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TASQWA

QUATERNARY VARIABILITY OF WATER MASSES
IN THE SOUTHERN TASMAN SEA AND THE SOUTHERN OCEAN
(SW PACIFIC SECTOR)

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Executive Summary

The TASQWA-Expedition to the SW Pacific and Southern Ocean

The TASQWA project aims at reconstructing the paleoceanography of the southern Tasman Sea and the SW Pacific sector of the Southern Ocean during the last 125,000 years. The results will be interpreted with respect to global climatic change and globally linked oceanic circulation. It is intended that this will lead to a better understanding of the paleoceanography and past climate in a key region which has, to date, undergone very little investigation.

The aims of the project were approached by means of an interdisciplinary expedition with scientists from institutions in Germany, Australia, France and New Zealand involved. To understand the present and past oceanic physiochemical processes the major investigations included studies of Recent planktic and benthic organisms, of hydrographic properties and fossil remains of planktic and benthic organisms (foraminifers, ostracodes, diatoms, radiolarians, dinoflagellate cysts, molluscs, gastropods; transfer functions), as well as sedimentological studies (carbonate mineralogy, granulometry). Geophysical measurements using an echo sounder (HYDROSWEEP swath mapping system) and PARASOUND aided in the description and interpretation of the sediments and thus helped clarify variability in the region's depositional history. Analyses of stable isotopes and radioisotopes will supply relative and absolute age determinations, as well as information on the physical characteristics of the oceanic water masses whose content of PCBs was also measured to get an impression of anthropogenic influences. In addition, other scientists will work in co-operation with the TASQWA project to provide investigations on biogenic opal which forms a major component in the Southern Ocean sediments.

In order to achieve these goals, the German RV SONNE visited the study area for a 28 day cruise during October and November 1998. Both long (approx. 12 m) and short (approx. 0.5 m) cores were taken to provide a sedimentary record from several sites in the Tasman Sea and Southern Ocean. Numerous scientific measurements and analyses in the water column and on the sediment surface provided a modern framework for calibration of the fossil data.

The project follows the guidelines set out in the National Climate Programme of the German Federal Government, as well as those for other scientific programmes which focus on obtaining high-resolution data for global climatic change (e.g. PAGES - Past Global Changes, IMAGES - International Marine Global Change Study).

Zusammenfassung

Die TASQWA-Expedition in den SW Pazifik und in das Südpolarmeer

Das TASQWA-Projekt beschreibt die Paläo-Ozeanographie der südlichen Tasman See und des SW pazifischen Sektors des Südpolarmeeres während der letzten 150 000 J., um sie im Kontext globaler Klimaveränderungen und einer global verbundenen ozeanischen Zirkulation zu interpretieren (Tiefenwasserstrom des Global Ocean Conveyor Belt). Es soll Informationen zur spätquartären Veränderlichkeit der Ozeanographie aus einem bisher nur unzureichend bearbeiteten Schlüsselgebiet liefern und zu einem besseren Verständnis globaler Klimaveränderungen beitragen.

Die Projektziele wurden über ein interdisziplinär verknüpftes Arbeitsprogramm der TASQWA-Expedition erreicht, an dem neben deutschen auch australische, neuseeländische und französische Forschergruppen beteiligt sind. Es wurden in der Hauptsache mikro- und makropaläontologische (Foraminiferen, Ostrakoden, Diatomeen, org. Dinoflagellaten-Zysten, Radiolarien, Mollusken, Gastropoden, Transfer-Funktionen), flachseismische (Sedimentecholot PARASOUND, HYDROSWEEP System), sowie sedimentologische (Granulometrie, Karbonate) Untersuchungen durchgeführt. Lebendes Plankton und Benthos wurden ebenfalls beprobt. Analysen von stabilen leichten Isotopen und Radioisotopen werden die Grundlage für relative und absolute Altersbestimmungen liefern, sowie Informationen über die physikalischen Eigenschaften der Wassermassen bereitstellen. Wissenschaftler aus bereits laufenden Projekten zu Untersuchungen von biogenem Opal aus dem Südpolarmeer kooperieren eng mit TASQWA.

Zur Durchführung von TASQWA wurde eine 28-tägige Expedition auf dem deutschen FS SONNE in die Tasman See und den SW pazifischen Sektor des Südozeans durchgeführt, auf der lange (bis zu 12 m) und kurze (ca. 0,5 m) Sedimentkerne auf mehreren Stationen entnommen werden konnten. Zusätzlich wurden Planktonfänge und zahlreiche Messungen und Analysen der hydrographischen Eigenschaften durchgeführt sowie die Sedimentoberfläche mit geologischen und biologischen Zielsetzungen beprobt. Bestimmungen von PCBs in den Wassermassen der südlichsten Stationen sollten helfen, den anthropogenen Einfluß zu bewerten.

Das durchgeführte Vorhaben steht in direktem Bezug zum nationalen Klimaprogramm der deutschen Bundesregierung, sowie zu internationalen Programmen, in denen Prozesse zeitlich-kleinskaliger, globaler Klimaveränderungen (z. B. PAGES-Past Global Change, IMAGES-International Marine Global Change Study, ODP-Ocean Drilling Program) im Vordergrund stehen. Im Rahmen der förderpolitischen Ziele wird das Projekt TASQWA der Klimasystemforschung und der Paläo-Ozeanographie zugeordnet.

Samenvatting

Kwartaire veranderingen van watereenheden in de zuidelijke Tasman Zee en de Zuidpool Zee (ZW Pazifische Sektor)

Het TASQWA project heeft tot doel om voor de laatste 125.000 jaar de paleoceanografie van de Tasman Zee en de zuidwestelijke sektor van de Zuidelijke Oceaan te rekonstrueren. De resultaten van dit onderzoek zullen gebruikt worden om de relaties te verduidelijken welke bestaan tussen de veranderingen in het wereld klimaat en het wereldwijde oceaan stromingspatroon. Dit alles heeft tot doel de paleoceanografie en het vroegere klimaat in deze zeer belangrijke, maar tot nu toe weinig onderzochte regio beter te begrijpen.

De doelstellingen van het project zullen worden verwezenlijkt door middel van een interdisciplinair onderzoeksprogramma waarbij wetenschappers van instituten uit Duitsland, Australie, Nieuw Zeeland en Frankrijk betrokken zijn. Om de huidige en vroegere oceanische physisch-chemische processen te begrijpen zullen studies worden gedaan van recente en fossiele overblijfselen van planktonische en benthonische organismen (foraminiferen, ostracoden, diatomeeen, radiolarien, dinoflaggelaten, mollusken, gastropoden); transfer funkties; hydrogeografische eigenschappen van het zeewater evenals studies van sedimenten (karbonaat-mineralogie en korrelgrootte analyses). Geophysische metingen met een echolood (HYDROSWEEP swath karteersysteem) en PARASOUND seismiek dienen ter ondersteuning van de beschrijving en de interpretatie van de sedimenten. Tevens zullen deze methoden helpen om de variatie in de afzettingsgeschiedenis van dit gebied beter te doorgronden. Stabiele - en radiogene isotopen-analyses zullen relatieve en absolute dateringen van de sedimenten geven, evenals informatie over de physische eigenschappen van het zeewater. Het PCB-gehalte in het zeewater wordt ook gemeten om een indruk te verkrijgen van de menselijke invloed op het huidige zeewater-systeem. Andere wetenschappers zullen nog onderzoek uitvoeren aan biogeen opaal, hetgeen een belangrijke komponent vormt van de sedimenten van de Zuidelijke Oceaan.

Om de hiervoor genoemde doelstellingen te verwezenlijken, heeft het duitse onderzoeksschip de RV SONNE een expeditie uitgevoerd gedurende een periode van 28 dagen in Oktober en November 1998. Zowel lange, 12 meter kernen en kortere kernen van ongeveer 0.5 m, zullen een goed beeld geven van de stratigrafie in verschillende regios in de Tasman Zee en de Zuidelijke Oceaan. Talrijke wetenschappelijke metingen en analyses van de waterkolom en het sedimentoppervlak zullen een goed beeld geven van de huidige toestand van het gebied welke dan gebruikt kunnen worden ter interpretatie van de oceanografische en klimatologische omstandigheden in het verleden.

Het projekt valt binnen het raamwerk van het Nationale Klimaat Programma van de duitse Regering, evenals dat van andere wetenschappelijke programmas zoals PAGES (Past Global Changes) en IMAGES (International Marine Global Change Study), welke alle tot doel hebben zeer gedetailleerde studies uit te voeren over globale klimaatveranderingen.

Resumé

Variabilité du Quaternaire dans les masses d'eau du sud de la Mer de Tasmanie et de l'Océan du Sud

Le projet TASQWA a pour but de reconstruire la paléocéanographie des 125,000 dernières années dans le sud de la mer de Tasmanie, et le secteur sud-ouest du Pacific de l'Océan du Sud. Les résultats seront interprétés en fonction des changements climatiques mondiaux, et de la circulation océanique du globe. Ceci devrait apporter une meilleure compréhension de la paléocéanographie et du climat passé, dans une région clé qui, jusqu'á aujourd'hui, n'avait été le lieu que de très peu de recherche.

L'objectif du projet fut accompli grâce à un programme de recherche interdisciplinaire impliquant des scientifiques venant d'institutions allemandes, australiennes, nouvelle zélandaises et françaises. Afin de comprendre les processus physicochimiques de l'océan, passé et actuel, les recherches principales ont porté sur les organismes benthiques récents, les propriétés hydrographiques et les organismes fossils planctoniques et benthiques (foraminifères, ostracodes, diatomées, dinoflagellées, mollusques, gastropodes; fonctions de transfert), ainsi que sur les études sédimentologiques (granulométrie, minéralogie des carbonates). Les mesures géophysiques, menées à l'aide d'un "echo sounder" (système de carte par balayage hydrographique) et d'un "PARASOUND", nous ont aidé dans la description et l'interprétation des sédiments, ainsi que pour clarifier la variabilité des régions à déposition. Les analyses d'isotopes stables et de radioisotopes apporteront des renseignements sur la détermination de l'âge relatif et absolu des sédiments, ainsi que des informations sur les caractéristiques physiques des masses d'eau océanique. Le contenu en PCB de ces masses d'eau fut mesuré afin de connaître l'influence anthropogénique. De plus, d'autres scientifiques travailleront en coopération avec le projet TASQWA et pourront fournir de plus amples informations sur les opales biogéniques, qui forment un composant majeur des sédiments de l'Océan du Sud.

Dans le but d'accomplir ces objectifs, le bateau allemand de recherche océanographique, RV SONNE, est parti en mission pendant 28 jours, du 16 octobre au 12 novembre 1998. De longues (approx.12 m) et de courtes (apprx. 0.5 m) carottes furent prélevées afin de fournir un enregistrement sédimentologique des différents sites de la mer de Tasmanie et l'Océan du Sud. De nombreuses mesures et analyses dans la colonne d'eau et à l'interface eau/sédiment donnent lieu à un outil de travail moderne pour la calibration des données de fossiles.

Le projet suit le règlement établi par le National Climate Programme du gouvernment de la République Fédéral d'Allemagne, ainsi que celui d'autres programmes scientifiques chargés d'obtenir des données de haute resolution sur le changement climatique de la planète.

Summary in Maori

Ko te whakatū anō i te paleoceanography i roto i ngā tau kotahi rau, e rua tekau mā rima mano ki muri mō te moana o Te Tapokopoko-a-Tāwhaki, me Te Moana Tonga i te rāngai Taha Puānga o Te Moana Nui a Kiwa, te whāinga a te kaupapa TASQWA. Ka whakamāramatia ngā hua i runga anō i te wehi ki te kōrure o te āhua o Tawhirimatea i te ao me te hono o te hurihuritanga moana ki te ao. Ko te koronga, mā tēnei kaupapa ka pai atu te māramatanga ki te paleoceanography me ngā āhua o Tawhirimatea i ngā rā kua hipa mō tētahi rohe matua, ā, ki tēnei wā, he tino itiiti nei te tūhurutanga kua whakahaerea.

Nā tētahi hōtaka whakarōpū i ngā tāngata me ngā whakanōhanga e mātau ana ki te pūtaiao i Tiamana, i Ahitereiria, i Aotearoa me Wīwī, i taea ai te whakatutuki ngā whāinga o te kaupapa. Kia mārama ai ki ngā tūkanga mō te āhua, mō te matū, mō te tinana o te papa moana me te wai moana o mua, o ēnei wā, i whakaurua atu ki te taha o ngā tūhuratanga nunui, ngā mātai o ngā rauropi planktic me ngā rauropi benthic o nā noa nei, ā, ngā mātai o ngā huanga o te moana me ngā toenga parawae rauropi planktic, rauropi benthic (arā, ngā foraminifera, ngā ostracodes, ngā diatoms, ngā radiolarians, ngā dinoflagellate cysts, ngā molluscs, ngā gastropods: me ngā pānga whakawhiti). I whakaurua atu anō hoki i te taha o ēnei mātai ngā mātai o te kirikiri, o te poharu (arā, te carbonate mineralogy, te granulometry). Nā ngā ine o te toka-ā-nuku i roto i te haere o te wā i āwhina ngā mahi whakaahua me ngā mahi whakamārama i ngā āhuatanga o te parataiao. Mā ngā tātaritanga o ngā stable isotopes me ngā radioisotopes e whakarite mai te tau o ngā parataiao me ngā mōhiotanga hoki ka pā ki ngā āhuatanga tinana o ngā papatipu o te wai moana kua oti nei te ine ngā PCB o roto. I tua atu i ēnei mahi, ka mahitahi ētahi atu kaimātai pūtaiao i te taha o te kaupapa TASQWA ki te whakarato i ngā tūhuratanga mō te biogenic opal tētahi o ngā tino huānga o roto i ngā parataiao o Te Moana Tonga.

Kia tutuki ai ēnei whāinga, i haere te tima RV SONNE o Tiamana ki te toro i te rohe mātai. I noho ki reira mō ngā rā e rua tekau mā waru i te marama o Whiringa-ā-nuku me te marama o Whiringa-ā-rangi i te tau 1998. I whakahaeretahitia te hōrete roa (tata ki te 12 m te roa) me te hōrete poto (tata ki te 0.5 m te poto) i ngā papanga maha i te moana o Tapokopoko-a-Tāwhaki me Te Moana Tonga. He huhua ngā ine me ngā tātaritanga pūtaiao i puta ake ki te parataiao o runga hei anga tōkarikari mō te raraunga parawae mō ēnei wā hou.

E whai ana te kaupapa i ngā aratohu kua whakatakotoria ki roto i te tuhinga a te Kāwanatanga o Tiamana, arā, ki roto i te National Climate Programme of the German Federal Government, ā, i te taha anō hoki o ēnei, ko aua aratohu e pā ana ki ētahi atu hōtaka pūtaiao e hāngai ana te aro ki te whiwhi raraunga whakataunga teitei mō te kōrure o te āhua o Tawhirimatea i te ao (hei tauira: PAGES – Past Global Changes, IMAGES – International Marine Global Change Study).

Acknowledgements

The TASQWA-expedition and ensuing scientific evaluations of the collected data and samples would not have been possible without the benevolent help and support from many persons and institutions. The cruise has been funded through grants from the German Federal Ministry for Science and Technology, represented by its project organisation BEO in Warnemünde, and through a grant from the European community which allowed us to invite several junior colleagues from EC countries. Partial financial support was also granted from AGSO (Canberra/Australia) and through an allocation to Gerrit van der Lingen (Christchurch/NZ) from the NZ FRST (Foundation of Research Science and Technology). Research licences and assistance during port calls were granted by the government agencies of New Zealand and Australia. The German embassies and their staff assisted us in organizing our visits to countries very distant from our home. Finally, the crew of RV SONNE under the able leadership of her captain, Master Hartmut Andresen, of the Shipping Company "RF Reedereigemeinschaft Forschungsschiffahrt" (Bremen) made every effort to make this scientific enterprise into the "roaring fourties" of the Southern Ocean and Tasman Sea scientifically as profitable as possible.

A digital version of this cruise report (pdf file) is published on the GEOMAR web page (www.geomar.de). The print files and all ship board data are distributed to all cruise participants on CD-ROM.

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1. Introduction

With respect to the globally-linked climatic system, in which oceanic circulation plays a crucial role, international research activities have begun to concentrate increasingly on the poorly-studied "marine" southern hemisphere. The importance of the Australian continent, New Zealand and their surrounding seas in palaeo climatology and palaeoceanography has so far been greatly underestimated. In response to the model of the "Global Ocean Conveyor Belt" - a globally-linked system of shallow and deep oceanic currents of different density (Broecker *et al.* 1998) - introduced by northern hemisphere scientists, Australian scientists coined the term "power-house-ocean". This shows that there now exists a preliminary understanding of the Southern (= Antarctic) Ocean and its interactions with the water masses of the Pacific, the Atlantic and the Indian Oceans and their controls on the global climate. Water masses influenced by the climate of the Antarctic continent, for example, can be traced to deep basins within all the oceans as far as the northern hemisphere.

Australasia is, by its geographical location, situated in a key position of the complex, oceanic circulation system. For example, important passages for water mass exchange, and thus energy transfer, between the Indian and Pacific oceans, are located both north and south of Australia. Furthermore, a close relationship exists between the climate of the continental landmasses of Australia and Antarctica, and the surrounding seas. Therefore, a direct connection between the climatic development of Europe and Australia through oceanic circulation patterns has to be inferred. Large portions of the deep water formed in the North Atlantic Ocean reach the Pacific Ocean by means of the Antarctic Circumpolar Current System. Thus, the investigation of these circulation systems, which have so far been insufficiently studied, will play an important role in understanding the different prognoses over the future development of the climate.

The TASQWA expedition (cruise SO136) was devoted to various themes around the Quaternary variability of water masses in the southern Tasman Sea and the SW Pacific sector of the Southern Ocean. The scientific shipboard participants (see Appendix A1) came from a variety of scientific institutions in Europe, Australia and New Zealand. The expedition was to add new data and knowledge to our understanding of the southern loop of the global conveyor belt; close linkages were established to the scientific parties of previous expeditions. TASQWA adds to the scientific knowledge of an area which has been visited by a view previous expeditions.

Other relevant expeditions in the same region

During August-October 1998 the RV JOIDES RESOLUTION of ODP visited the waters S and E of New Zealand to conduct ODP Leg 181 (Carter *et al.* in prep.) and to supplement previous ODP and DSDP legs. In May 1997 during the second leg of the IMAGES III iphis expedition from Hobart to Christchurch (Nees *et al.* 1998) with the French RV MARION DUFRESNE II 7 sediment cores up to 30 m in length were recovered using the ultra long piston corer. At present these cores are in the laboratories for sample preparation. The results of this cruise are in close relationship with the TASQWA project. G. van der Lingen and K. Swanson (both from Christchurch/NZ and participants of TASQWA) undertook an expedition in October 1995, with the help of a fishing trawler, into the eastern part of the Challenger Plateau and used box corers and a short piston corer for sediment sampling. Oceanographic investigations were the main objective of this cruise. New Zealand scientists are presently conducting systematic surveys of oceanography and seafloor characteristics in the waters around New Zealand (using i. a. the New Zealand RV TONGAROA).

In 1995 the area of the central and W South Tasman Rise was investigated by the Australian RV RIG SEISMIC (Exon *et al.* 1995 a); this study included an intensive sediment coring program. During this cruise numerous box cores and dredge samples were recovered. In 1994 Australian scientists of the AGSO used the French RV l'ATALANTE for seismic investigations in the same area. High-resolution bathymetric data (swath mapping) were produced (Exon *et al.* 1994). In addition, during 1994 a palaeoceanographically oriented expedition, with the Australian RV FRANKLIN, was executed in the region of the S Tasman Rise and the SE Tasman Plateau. In 1988 the French RV MARION DUFRESNE undertook an expedition to the Antarctic Ocean S of Tasmania. A set of box cores and three Kullenberg cores were retrieved. The results of the investigations (Nees *et al.* 1998) on this material will be used as a reference for the planned transects.

In 1987 the AGSO undertook a sedimentologically oriented cruise into the area north and west of Tasmania using the Australian RV RIG SEISMIC (Exon *et al.* 1987). This cruise had predominantly exploratory objectives. The German RV SONNE visited the area of the Lord Howe Rise and S Tasman Plateau during 1985 (Hinz *et al.* 1985). This cruise also concentrated predominantly on exploratory objectives. Already in the years 1967/68 the American RV ELTANIN retrieved a large number of piston cores with pilot cores from the Southern Ocean (Watkins & Kennett 1971a). Most material from these early expeditions has already been used for analyses or is no longer suitable for modern analytical methods.

2. Narrative of the TASQWA expedition 1998

Oct. 16-18

The German RV SONNE left Wellington/NZ on October 16, 1998 at 08.00 pm to proceed to the first station (plankton tow, CTD, gravity corer, multicorer) to the west of the South Island of New Zealand, on the southern flank of the Challenger Plateau, as the junction of the Lord Howe Rise with the New Zealand continental margin is called. The ship had entered port on October 15, 1998 after successfully completing SO-135 which was devoted to phenomena of oceanic crustal rocks and processes between Tonga and New Zealand where the research submarine JAGO had been deployed at shallow water depths for direct observations and sampling of rocks, precipitates, deposits and faunas in and around active hydrothermal venting areas.

On the first station of SO-136 in 958 m of water we successfully sampled the water column by means of plankton nets and CTD as well as the sediment surface (by MUC = Multicorer) and upper sediment layers (by GC = Gravity Corer). The sediment comprised hemipelagic calcareous sandy muds.

Oct. 18-25

During the night from Sunday, Oct. 18 to Monday Oct. 19 we made the transit to the second station on the Challenger Plateau, in approx. 1500 m of water. When arriving well before midnight a rough front caught up with us, with wind speeds of some 40-50 kn, resulting in considerable difficulties with the instruments. Despite of this we were able to take a 9 m - gravity core and conducted the other measurements successfully. After completing the station we sailed for the transect over the eastern Campbell Plateau and used the available time to describe and sample the sediment cores. The weather calmed during the transit and we enjoyed for some time, a surprisingly tranquil southern SW Pacific.

Wednesday, Oct. 21 in the afternoon we arrived at the subantarctic slope of the E Campbell Plateau and began to map sediment distributions. After a survey along the entire transect we were able to define eight stations covering a range of water depths from >4500 m to approx. 500 m; only the two planned stations between 2000 and 4000 m water depth did not seem to harbour enough sediments for acquiring a long core. We still had not crossed the subantarctic frontal system, but it caught up with us during late Thursday, when we met surface waters of +5-6° C while air temperatures dropped to 3-4° C. During fronts which were passing the area we even got some light snow showers.

The transect over the eastern Campbell Plateau was completed with mixed results, at least as far as sediment coring is concerned. The recovery at the deep stations was not satisfying because of the sediments being lag deposits of the intense deep current systems along the foot of the Campbell Plateau or because of the virtual lack of any sediments between 2000 and 4000 m water depth. At the shallower sites we encountered highly calcareous foraminiferal sands with relatively little fine-grained material which resulted in difficulties in penetration and in retaining the sediments in the core barrel. Anyway, we obtained excellent short box cores from each of the stations and one 4 m gravity core from 980 m of water depth. The epibenthos sledge was deployed at the upper slope of the eastern Campbell Plateau, water and plankton sampling was carried out successfully at all stations as planned. Good recovery of ostracodes has been achieved at most sites, except the deepest one at the foot of the Campbell Plateau. At some site, in particular in the Tasman Sea sites of last week, strong dissolution has been observed. In the sample from the eastern Campbell Plateau benthic ostracodes with soft tissues intact have been found. Coarser dredge materials were dominated by gastropods and hermit crabs (living in gastropods shells) as well as scaphopods.

Since Sunday, Oct 25 early morning, the RV SONNE was riding off heavy weather, with winds up to Bft.10, with her bow heading into the wind and heavy, up to >10 m high swells. After heavy rains the sun was shining and we hoped to be soon underway to the south-western Campbell Plateau and the adjacent Emerald Basin.

Oct. 25-Nov. 1

During the night of Oct. 25/26 our hopes for calmer weather were fulfilled and we were able to start our transit towards Campbell Island from where we wanted to work along a transect across the southern slope of Campbell Plateau towards the Emerald Basin. Underway our colleague from NIWA deployed XBTs in regular intervals. Tuesday morning we arrived at our first station in approx. 600 m of water and completed sampling with the plankton net, CTD, box corer, gravity corer as well as epibenthos sledge (in calm and sunny weather). Despite a substantial low which is looming behind the horizon we hoped to complete this transect during this week before entering the Tasman Sea.

As of mid-week we had worked our way downslope from a station in approx. 500 m of water just to the South of Campbell Island to mid-slope depths around 3000 m. Plankton and water column sampling were successful, and only the sediment sampling programme was not satisfying. Whereas the shallow station allowed to take some excellent box and gravity cores, success decreased with increasing water depths. The main reason has to be seen in changes of sediment properties. Whereas the seafloor was covered by foraminiferal sands imbedded in a fine-medium grained matrix at the shallow station, the fine sediment fraction disappeared with increasing water depths with the result that the box corer did not penetrate very deep (but still collecting sample), but that the gravity corer despite some penetration did not succeed to bring up core (probably the collected sediment was washed out). In water depths >2500 m we reached a very rugged terrain with probably no sediment cover because of deep current erosion. After completing the 3000 m station we therefore decided to run a short survey over the deeper slope of the plateau in an attempt to find any region with an identifiable sediment cover. The survey showed that the deeper part of the slope of Campbell Plateau consists of very rugged terrain, with virtually no sediment - so we were lucky to find a small sediment drift in approx. 4000 m of water. Despite strong south-easterly(!) currents we succeeded to sample these Quaternary deposits by box corer; they consist of fine-grained, wellsorted, homogenous foraminiferal sands. Predictably the gravity corer failed in this type of sediment.

After completing this station and the survey we commenced our transit across Emerald Basin in reasonably good weather. By Sunday we were able to complete 3 stations, with the regular sampling programme and with the collection of some spectacular sediment cores. At the southernmost station 4 *in situ* pumps were deployed for 8 hours to sample the water column at various depths for PCBs. Sunday night we were completing station work in the Emerald Basin; passing Macquarie Island at some distance to the North we steamed north-westward into the Tasman Sea on our way to the next sites at the Tasman Rise.

Nov. 1-8, 1998

The last station in the western Emerald Basin, occupied during the night of Sunday, Nov. 1 was one of the expeditions highlights because of the >10 m long sediment core through a colourful sequence of glacial and interglacial sediments, clearly different from the diatomaceous oozes and muds which we had found a few hours earlier approx. 50 nm to the S of this station. The boundary between the waters to the S of the Antarctic Convergence and those to the N is clearly marked in the composition of the sediments. The last CTD had to be abandoned because of some technical problems with the winch which is now being fixed by the able members of RV SONNE's crew. In the morning of Monday, Nov. 2 we were underway across the southern part of the Tasman Sea to the first stations over the southern extensions of the Tasman Rise, in stormy weather, strong head winds and swells.

In the early days of the week the weather calmed though temperatures remained low. Only slowly as we worked our ways northward sea surface temperatures rose from approx. 3° C in the southernmost Tasman Sea to 8-9° C on Thursday and Friday over the southern Tasman Rise. Plankton sampling, hydrographic measurements and the deployment of *in situ* pumps for the collection of PCB's was continued successfully, but the collection of sediment samples was increasingly difficult. On our first station in the southern Tasman Sea we encountered a dense pavement of manganese nodules. Despite some discussion we attempted successfully a 12 m gravity core, which brought 7.7 m of core and which obviously penetrated several manganese pavements at some distance below the seafloor - this core will be difficult for stratigraphic studies.

After leaving this station our luck to find sediments suitable for coring ran out for some time. The entire southern Tasman Sea along the cruise track was covered by a dense layer of presumably manganese nodules or crusts as we could see on the PARASOUND records. The profiles indicated also that a pelagic sediment sequence of several tens to hundreds of metres in thickness with a stratification conform to the undulating sea floor was found below this pavement. We tried to break through this lid on the seafloor but harvested only a slightly bent empty box corer.

Towards the end of the week we reached the southern Tasman Rise and our hopes for better success with the sediment coring rose. We completed a full station at the RV MARION DUFRESNE coring site on the southern Tasman Rise and recovered a first rate box core of foraminiferal nanno oozes to document the undisturbed surface sediments at this site. Proceeding further N and E we encountered again pure foraminiferal sands at the seafloor which with some luck could be box cored, but which denied sediment recovery to the gravity corer.

Since Sunday, Nov. 8 early in the morning RV SONNE was proceeding further to the N along the E flank of Tasman Rise. In the course of the morning an energetic low caught up with us and as of Sunday afternoon RV SONNE was riding on 16 m waves with her bow pointing into a fresh to strong gale. We hoped to be able to proceed with station work by Sunday night.

Nov. 8-12, 1998

The TASQWA expedition came to an end during the first days of this second week in November when RV SONNE entered the port of Hobart (Tasmania/ AUSTRALIA) in the early morning of Nov. 12. The RV SONNE will leave port the same evening to transit to Fremantle where she will meet her next scientific party. The day in Hobart was devoted to discharging the scientific cargo of the TASQWA-expedition, a press conference related to the results of the expedition was held in the morning, and a formal reception was organised in the late afternoon of the same day to have an opportunity to meet with officials from Canberra as well as Hobart and local dignitaries. The scientific institutions located in Hobart have been and will be important partners of German research institutions within marine and polar sciences. The participation of Australian and New Zealand scientists on the TASQWA expedition will provide a promising base for the continuation of this collaboration in the scientific exploration of the Southwest Pacific and the adjacent Southern Ocean.

The early days of this week were devoted to conclude the science programme of the expedition. In preparation for the ODP Leg proposed by Australian scientists (Exon *et al.* 1995b) for the Tasman Rise and Tasman Plateau in the year 2000 RV SONNE carried out detailed surveys of bathymetry (HYDROSWEEP) and sediment distributions (PARASOUND) in the immediate neighbourhood of the proposed drill sites. In addition we completed station work over the eastern Tasman Rise which is covered by soft and dominantly biogenic pelagic sediments. Despite the failure of the corer on the last site in the deep area between Tasman Rise and Tasman Plateau, we were able to collect 2 excellent sediment cores from the eastern Tasman Rise. The last days of the cruise were also devoted to finalise the scientific measurements in the laboratories, with particularly interesting data from the MST core logger and the colour scanning systems which already at the present stage allow correlation of a number of cores to well dated records from distant parts of the southern oceans.

The last day before entering port was devoted to pack the instruments and the collected samples as well as to tidy the ship for the oncoming scientific party. These activities were accompanied by favourable weather conditions and temperatures rose as we came closer to Tasmania.

The last weekly report of the TASQWA Expedition also provides for an opportunity to formally express the gratitude of the shipboard scientific participants to the supporting funding organisations as well as to the able RV SONNE crew under Master Hartmut Andresen from RF Reedereigemeinschaft Forschungsschiffahrt in Bremen. We were all impressed by the excellent working atmosphere on the RV SONNE and we hope to be able to return in the future.

3. Objectives of TASQWA

The TASQWA-area is a relatively poorly known area of the SW Pacific and Southern oceans. It comprises the plateaus around the South Island of New Zealand, the Emerald Basin and the southern Tasman Sea (Fig. 1). The project TASQWA has several main objectives which are outlined below:

- to obtain a detailed set of carefully selected measurements and samples characterising this segment of the SW Pacific and Southern oceans to conduct studies of the physical, chemical and biological oceanographic properties of the water masses and to use these data for establishing a framework for palaeoceanographic reconstructions based on seafloor sediment samples;

- to supply information, which documents global climatic fluctuations and contributes to a better understanding of the variability in global oceanic circulation in one of its key region;

- to reconstruct the palaeoceanography of the Southern Tasman Sea and the SW Pacific sector of the Southern Ocean and to interpret the data in a global climatic context (through a southern-northern hemisphere comparison), with a main emphasis on the variability during the youngest geologic past (the past 1 mio. years);

- to supply high-quality, high-resolution data on a temporal scale, for interdisciplinary oceanographic research in an area which, to date, has undergone very little investigation.

4. Research area

The South Pacific and Southern oceans are regions of intense oceanographic processes because of their surface waters current regimes (Fig. 2) and because of the mode of modern Southern Hemisphere bottom water renewal. They are regions of very steep, horizontal as well as vertical oceanographic gradients and of fast currents which alter compositions of seafloor deposits because of chemical dissolution and because of mechanical erosion.

The segments of the SW Pacific Ocean and the SE Indian Ocean between New Zealand, Tasmania and Antarctica are unique because of several reasons, namely

- they comprise a complex system of submarine plateaus and ridges which rise well above the adjacent abyssal plains and which under favourable conditions are protected against deep-water erosion as well as carbonate dissolution, hence allowing to establish a N-S transect of sediment cores with undisturbed stratigraphic records from temperate to high southern latitudes;

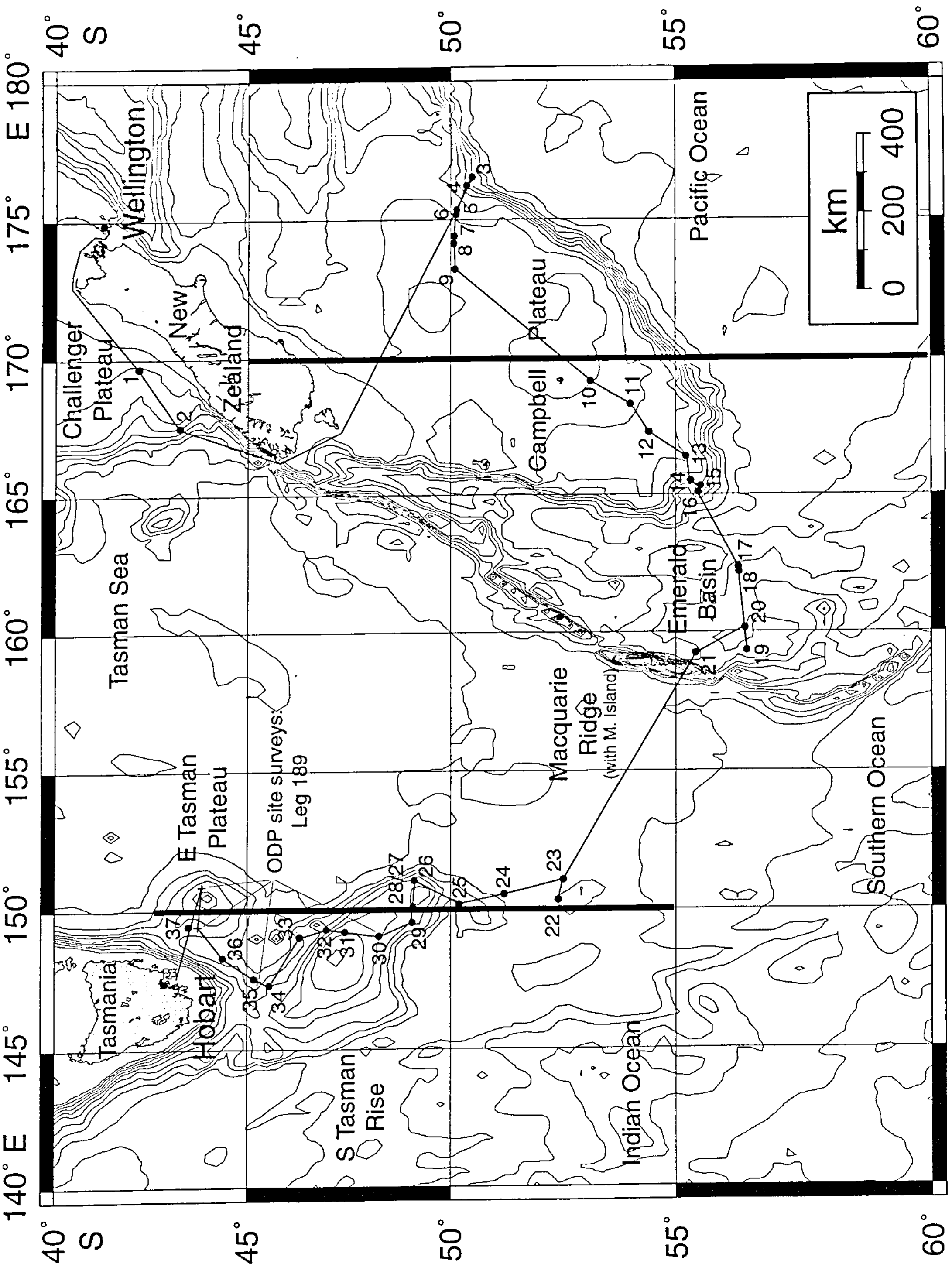

Fig. 1: Cruise track of the expedition TASQWA-SO136 including the location of sampled stations and ODP site surveys. Bold lines indicate the position of the oceanographic profiles (s. Fig. 3).

- the presence of Australia/Tasmania and New Zealand represent physical constrictions of the circum-Antarctic surface circulation (Schuur *et al.* 1998) with the result that the major oceanic frontal systems are found at relatively small distances from each other while they preserve their major characteristic:

- both surface and deep currents seem to be topograpically controlled;

- the geological signals produced by Antarctic surface water masses can be discerned particularly easy from those of the sub-Antarctic temperate water masses.

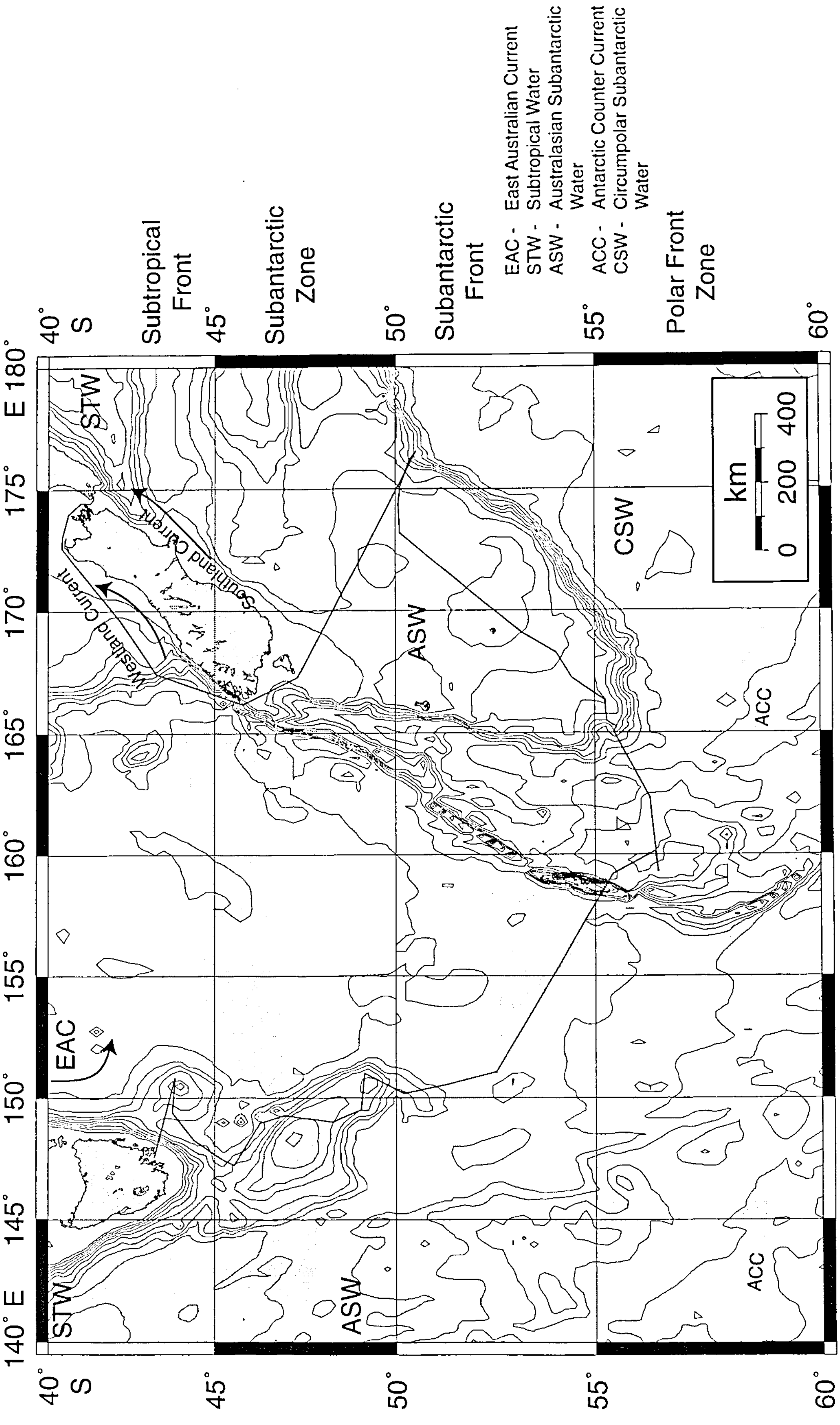

Fig. 2: Surface oceanography of the SW Pacific. Shaded areas indicate the seasonal range of position of fronts and zones.

Prime target areas in the studies sector of the SW Pacific and Southern oceans, therefore, were:

- the Emerald Basin and
- high accumulation areas east and west of the Campbell Plateau.

Sediment core profiles, at various water depths on the eastern and western edges of the Campbell Plateau, provided information concerning variability in the intermediate and deep water masses. In addition, sites which lie on a longitudinal transect through the Emerald Basin provided further oceanographic information concerning variability across several existing oceanographic fronts. A further point of interest was to find out whether ice-transported material is present as this would provide information about episodic, climatic cooling events and finally, to determine whether these could then be synchronised with the North Atlantic "Heinrich Events". The investigation of sediment driftbodies will help to interpret the variability and history of the Pacific "Deep Western Boundary Currents".

Main target areas in the Southern Tasman Sea and Australian sector of the Southern Ocean were:

- South of the Tasman Rise and
- the southern edges of the South Tasman Rise.

Here, sediments were to be retrieved in order to attain information on the palaeoceanography of the circum-Antarctic water masses.

In reference to an ODP drilling proposal, Australian scientists (Exon *et al.* 1995b)) have already performed intensive seismic and sedimentological investigations, which will ideally complete the planned investigations in the western region south of the Tasman Rise. On the eastern flank of the rise an increased sediment accumulation was expected, which will provide an opportunity for a high-resolution investigation to take place. The planned longitudinal transects in the southern region of the South Tasman Rise were to give additional information on oceanic variability across several oceanographic fronts.

5. Geological and oceanographic framework

Some of the major trades in the geological structure and in the oceanography of the TASQWA region are given in Figs. 1, 2 and 3 (see Tab. 3, Chapter 8.3.1 for characteristics of the major water masses). Whereas some of the oceanographic measurements are regionally distributed over the entire region (Bradford-Grieve *et al.* 1991, Tomczak & Godfrey 1994), the sediment cores have been collected to address the palaeoceanographic history of the region during the late Quaternary when the structural framework and the major current systems of the area were firmly established.

Primarily, two time intervals were to be examined in the TASQWA Project, whereby the detailed questions to be addressed would depend on both sediment recovery and resolution, independently:

- Holocene and Recent (Younger Dryas, Holocene Climate Optimum and Little Ice Age);

• Late Quaternary Time Series (0 - 125 ka).

The possible effects of the Younger Dryas (10-11 ka) in the southern hemisphere has undergone very little investigation so far (Blunier *et al.* 1998). However, the available results indicate that, when compared to the northern hemisphere, an earlier Holocene Climatic Optimum occurred and a possible warming during the Little Ice Age took place. Major climatic changes, seen as glacial terminations and events similar to the "Heinrich Events", were to be established and inter-hemispherical correlations will be attempted with respect to a possible global, climatic coupling.

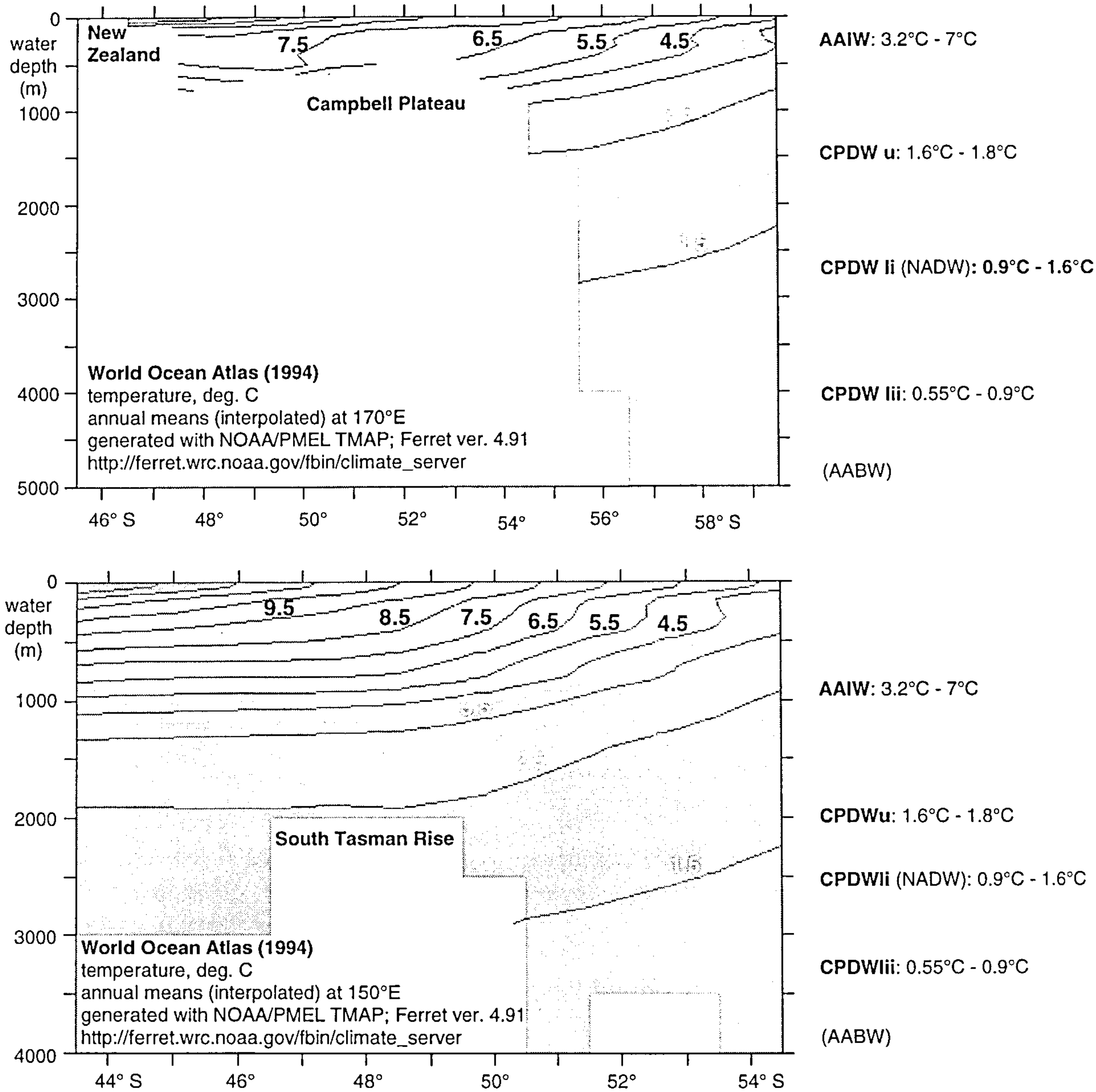

Fig. 3: Depth - temperature profiles along longitudes 150° E and 170° E.

6. Ship and equipment

Name:	SONNE
Nationality:	German
Owner:	Partenreederei SONNE
Shipping agency:	RF Reedereigemeinschaft Forschungsschiffahrt GmbH Haferwende 3 D-28357 Bremen, Germany Ph: +49 421 20766.0; Fax. +49 421 20766.70 E-mail: rf@bremen.rf-gmbh.de
Total length:	97.61 m
Draught:	6.8 m
Netto tonnage:	1,055 NT
Gross tonnage:	3,516 BRZ
Propulsion:	diesel electric
Cruising speed:	12.5 kn
Intern. call sign:	DFCG
INMARSAT numbers:	Ph: 1120 525 (INMARSAT A und C) Fax: 1120 534

7. Weather and sea

The wind direction and wind speed from Oct. 16 to Nov. 12 were recorded automatically every minute by the ship's weather station. These data are stored at the ship's computer together with the latitude and longitude readings – one file every four hours. The record has been used for the plots of air temperature, airpressure and wind speed.

Additionally the navigation officers on bridge noted the observable swell and weight height, clouds and rain conditions in the deck log book at least every two hours. Weather maps produced by the Bureau of Meteorology in Auckland and Canberra were demanded twice to three times a day. These maps are archived only during the cruise, as well as the weather data stored on the computer, which is not presented to meteorologists, will be deleted after the cruise.

Cruise observations

Leaving Wellington, on the evening of the Oct. 16, the weather was fine with temperatures around 16° C [60.8° F]. When RV SONNE sailed, Wellington presented itself with a wonderful sunset. Soon after passing Cook Strait, the predicted swell (Tab. 1) started which was present almost during the entire cruise with changing intensities (max. on Oct. 25 and Nov. 8) not always in correlation to the wind speed and cloudiness.

Tab. 1: Wind speed and sea disturbance.

wind speed	description	knots	m/s	sea disturbance	description	height of waves
(Beaufort)				(Beaufort)		(m)
0-3	calm	0-10	0–5.4	0-3	calm to smooth	0–0.9
3-6	breeze	7-27	5.5–13.8	4-6	moderate to rough	0,9–3,4 3-5,5
7	near gale	28-33	13.9–17.1	7	high	5–10
8	gale	34-40	17.2–20.7	8	very high	9–16
9	strong gale	41-47	20.8–24.4	9	precipitous	>15
10	storm	48-55	24.5–28.4			
11	violent storm	56-63	28.5–32.6			
12	hurricane	>64	>32.7			

Cloud cover was dominant over clear skies throughout the cruise, but at least there were some sunny intervals. Rain squalls were encountered infrequently. Nevertheless, in case of rainfalls these were presented fairly severe with heavy falls and associated strong local winds. During the late days of October, when we were close to subantarctic waters, and after we had crossed the subantarctic front (Oct. 31), a slight snow storm appeared.

The air temperature (Fig. 4) was friendly with around 16° C [60.8° F] when the cruise started, but constantly decreasing as we were sailing south. While the ship was trapped by a heavy swell (Oct. 25), the temperature increased from 2° C [35.6° F] to 10° C [50° F]. The minimum was reached with –1.1° C [30° F] while we have been running SO136–104CTD on Oct. 31st, 13:36 NZST (56°74'82"S; 159°60'06"E).

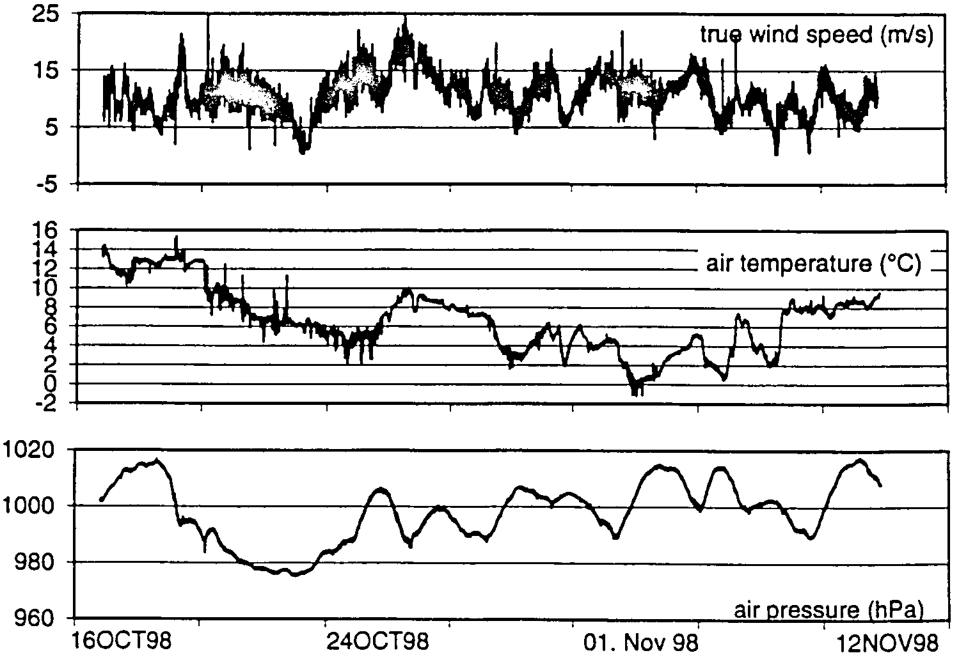

Fig. 4: Plots of wind speed, air temperature and air pressure during the TASQWA cruise taken from the ship board weather station. The changing air pressure indicates the frequent lows of the "roaring forties".

Wind speed during the cruise was as high as presumed, with a mean true wind speed of 8 – 15 m/s. The maximum was reached on Oct. 25, 06:08 NZST, when 25.2 m/s were recorded.

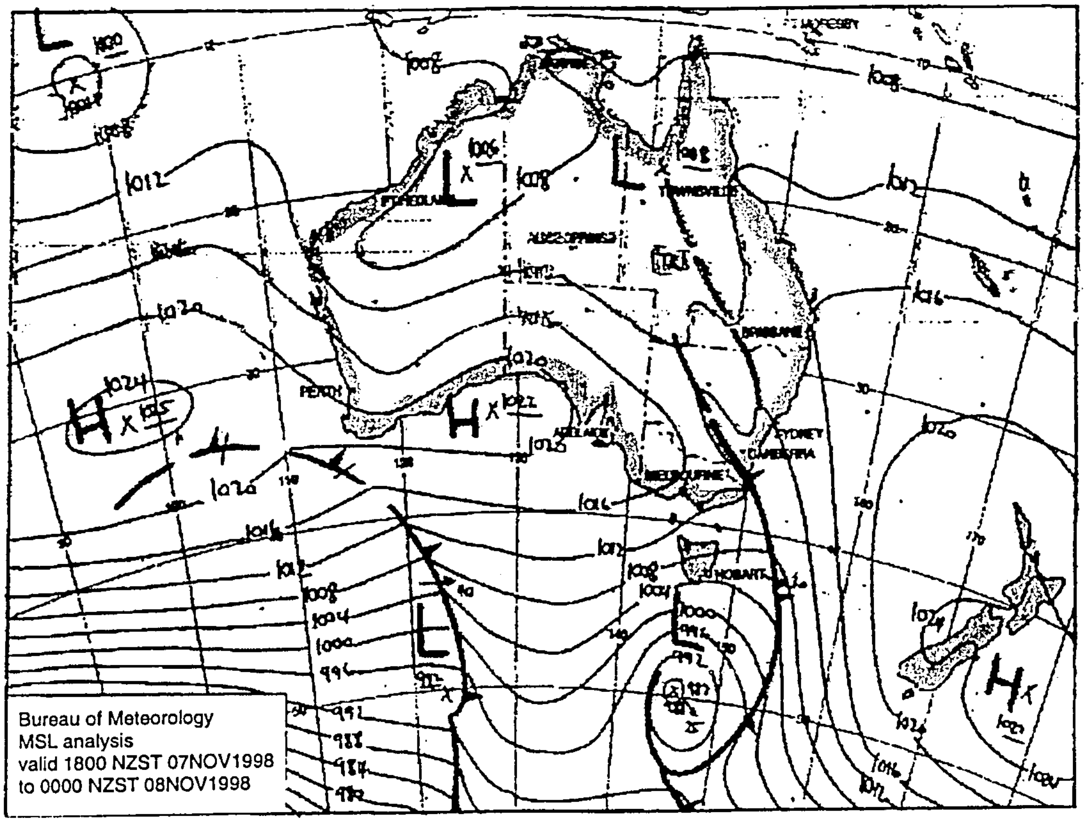

Fig. 5: Typical weather pattern of the Southern Ocean, Australian and New Zealand sector.

The scientific sampling on board was influenced twice due to uncomfortable weather conditions. First, on Oct. 25, when the RV SONNE has been forced to point her bow towards the swell to ride out the storm and the waves with up the 15 m height. This situation revived on Nov. 8 on the South Tasman Rise, and again the RV SONNE stood stationary for at least 12 hours (Fig. 5). Both situations were induced by a rapid fall of the airpressure (with the co-occurrence of temperature increase) as shown in Fig. 4.

8. Results of the scientific programme of TASQWA

Data, detailed descriptions and figures are given in the Appendix. Additionally all data including this cruise report in digital form are provided to all cruise participants in CD-ROMs.

8.1 Sea floor

8.1.1 Seismics and bathymetry

HYDROSWEEP/PARASOUND Systems - Their operation and performance during the cruise

The HYDROSWEEP system aboard RV SONNE is a 15.5 kHz, 59-beam echosounder with hull-mounted transducers. It has an angular coverage of 90°, giving a swath-width of 2 x water depth. Both bathymetry and backscatter amplitudes are recorded. For the shipboard raw data acquisition and processing a constant water velocity of 1500 m/s was assumed. Post-processing of the multibeam data will be done with better sound velocity profile data - using the CTD data collected during the cruise and the global Levitus data set.

The PARASOUND system is a narrow-beam (~4.5°) sub-bottom profiling echosounder that can operate at low frequencies of 2.5-5.5 kHz. The system has a fixed primary frequency of 18 kHz, and a selectable set of slightly higher primary frequencies (20.5-23.5 kHz). By the 'parametric effect', simultaneous transmission of two primary frequencies generates a narrow pulse of low frequency (difference in primary frequencies). Electronic compensation for ships motion ensures that transmission is vertically down; heave compensation is also applied. Both HYDROSWEEP and PARASOUND survey systems are manufactured by Atlas Electronik GMBH.

After some experimentation it was found that a frequency of 4 kHz and a 2-cycle pulse was the best compromise for maximum penetration and resolution, and so these settings were maintained for the entire cruise. The analogue data were recorded on Atlas DESO 25 recorder (continuous paper roll). The data were also recorded in digital format (modified SEG-Y) by a ParaDigMA (V.4.0) acquisition system. ParaDigMA was developed jointly by the Department of Geosciences, University of Bremen, and Atlas. Data were sampled at 40 kHz over a 200 m (266 millisecond window). Output from this system was displayed on an A4 colour printer. The PARASOUND produced excellent sub-bottom seismic profiles during the cruise, displaying high-resolution stratigraphy to sub-bottom depths of up to 150 m.

In general, both systems performed well during the survey. However, data quality deteriorated significantly during periods of bad weather and heavy seas, when wave height was more than several metres and wind speeds were 30 kts or more, resulting in severe cavitation at the transducers. Under these conditions, data quality was further reduced when the ship pounded directly into oncoming seas, and when a rugged seafloor made it difficult to maintain bottom track. Only about 2 days of data were lost during the cruise because of bad weather.

Navigation accuracy and reliability for control of the survey data was excellent during the cruise. Differential GPS with SkyFix reference stations (main stations - Melbourne, Sydney, Auckland) gave ~3-5 m accuracy, and was available at least 95% of the time. The ship was at the limits of reference station coverage while on the Campbell Plateau. When DGPS not available (< 5% of the time), the Russian GLONASS satellite system (~10 m accuracy) - in combination with GPS (~100 m accuracy), was utilised.

General comments on the surveys

The use of these systems was vital during the survey, particularly for locating suitable geological sampling sites and for mapping the local geological environment. The survey of four proposed ODP Leg 189 sites will do much to ensure that safety and environment panel requirements are met. These additional data will help to establish the final best position for each of the sites.

Data collected during transits and at sites will contribute to the regional bathymetric and high-resolution seismic data base. These data will greatly assist planning of future sampling cruises, and will allow production of improved bathymetric and sediment maps. During the survey, images and maps produced from the recently released predicted bathymetry gridded data set (based on satellite altimeter data) of Smith & Sandwell (1997) were put to very effective use in survey planning. This was particularly so for the southern South Tasman Rise area, where the available GEBCO maps were found to be too generalised and inadequate. There was remarkably good correlation of our new SO-136 bathymetry data with topographic features in the predicted bathymetry maps.

Sampling site descriptions based on PARASOUND and HYDROSWEEP

Site 1 (Southern Challenger Plateau Transect)

Mean depth: 958 m
Samples recovered: Grey silty-fine sandy foraminiferal ooze in GC (7.70 m) and MUC (0.18 m).

This site is located on the gently-sloping western flank of the southern Challenger Plateau. The PARASOUND profile shows a flat seafloor and parallel sub-bottom reflectors to at least 70 m below seabed. An upper sequence, about 22 m thick, is relatively highly reflective and finely stratified. Reflectors in the lower sequence are more widely and irregularly spaced - typically 5-10 m.

About 10 km SW of this site, there is a dramatic change in seafloor structure, with several canyons, up to 300 m deep, incised into the strata.

Site 2 (Southern Challenger Plateau Transect)

Mean depth: 1535 m
Samples recovered: Grey foram-bearing clayey silt in GC (8.92 m) and BX (0.22 m).

The site is located on a moderately steep slope of ~2°. The seafloor is generally smooth, except for a 60 m high (?fault) scarp crossed during the benthic dredge run. The sub-bottom reflectors are much the same as at Site 1, with the top ~20 m being finely stratified. There is evidence of an erosional unconformity at ~60 m sub-bottom.

Site 3 (East Campbell Plateau Transect)

Mean depth: 4530 m
Samples recovered: Sandy foraminiferal ooze with quartz-rich bands in BX (0.38 m); GC bent, nil sample.

Site 3 is located about 10 km south-east of the base of the eastern Campbell Plateau, on the north-west side of a gentle rise on the abyssal plain. The PARASOUND profiles show an undulating seabed in the area. The top 15 m of the sub-bottom is strongly reflective and hummocky in character. Bedding is fine and wavy, and mostly discontinuous with small dip (?cross-bedding). The records show no significant sedimentary structures below ~25 m. The near-surface, hummocky sediments are interpreted as sediment drifts deposited by the action of strong bottom currents.

Site 4 (East Campbell Plateau Transect)

Mean depth: 3449 m
Samples recovered: In BX (0.19 m) - foraminiferal sand on top, diatom silt/clay (yellow-brown) below.

This site is situated on a moderately steep (2°) SSE-facing slope on the lower flank of the eastern Campbell Plateau. A 50 m deep SSE-running canyon lies about 2 km to the west. The seabed at the site is undulating, and in the PARASOUND profiles is seen as a sharp, eroded contact, with some offlap visible. The upper 10-20 m shows semi-continuous wavy bedding. Immediately below this layer, no major reflectors are visible. However, just upslope and downslope from the site, a strong unconformity with major relief (?bedrock/basement) is present in the profiles at 40-60 m depth.

Site 5 (East Campbell Plateau Transect)

Mean depth: 1574 m
Samples recovered: White, medium-coarse foraminiferal sand in BX (0.19 m); 2 x GC-6 nil.

This site, on the upper flank of the eastern Campbell Plateau, lies on a flat area about 2 km south-east of a 70 m high eroded escarpment that strikes north-east. A 20 m deep channel has been cut immediately beneath escarpment. In the area of the site, a young (?Quaternary) well-stratified sediment wedge extends 7 km in a downslope direction. The site is located on the upper part of the wedge. The well-stratified upper sequence is mainly 5-15 m thick, underlain by a less stratified and more transparent unit (0 to > 20 m thick) that fills and overlies a prominent erosional unconformity with significant relief. At the site itself, the upper well-stratified unit is 10 m thick.

Site 6 (East Campbell Plateau Transect)

Mean depth: 1360 m
Samples recovered: White, sandy foraminiferal ooze in BX (0.19 m) and GC-6 (4.07 m).

Site 6 is situated on the upper eastern Campbell Plateau, on the side a smooth and gently sloping local rise (~35 m high). Hills, over 100 m high, lie to the west. The closest is a steep-sided edifice > 100 m high, located 5 km WSW of the site. It is probably a Tertiary volcano.

The rise on which Site 6 is located is underlain by a highly stratified sequence up to 30 m thick that overlies and generally drapes a high-relief erosional surface (angular unconformity). The upper sequence onlaps and downlaps the unconformity in places. The sequence appears to have been partly eroded at the seabed, and the sequence is entirely absent on a rise immediately to the west. The sequence comprises two sub-sequences, each approximately of equal thickness, but with the top sub-sequence more reflective than the lower. The sequence beneath the unconformity is relatively transparent and 100 m or more thick. It, in turn, is underlain by a very strong, broad and irregular horizon - perhaps a volcanic surface (?lava flow).

Site 7 (East Campbell Plateau Transect)

Mean depth: 960 m
Samples recovered: White, fine foraminiferal sand in BX and GC-6 (2.91 m).

Site 7 is located on a gentle SE-facing slope on the upper Campbell Plateau. About 4 km east of the site, a SSE-running canyon has cut 50 m into the surface of the plateau. The upper sequence at this site is well-stratified and is seen in the PARASOUND profiles as an undulating and down-slope thickening series of beds. At the site the sequence is ~40 m thick. It is underlain by an erosional (angular) unconformity. The underlying section is structurally complex, with small tilt blocks and associated syn-fault infill, plus at least two strong horizons (probably unconformities).

Site 8 (East Campbell Plateau Transect)

Mean depth: 756 m
Samples recovered: White, fine foraminiferal sand in BX (0.17 m) and GC-6 (2.90 m).

The plateau surface at the site is smooth and of very gentle slope. The near-surface is highly reflective. The sedimentary section comprises an 18 m thick upper sequence that is well-stratified parallel to the surface, and a sub-horizontally layered lower sequence. A pronounced unconformity with low-angle offlap on the lower sequence separates the two. The lower sequence is at least 100 m thick.

Site 9 (East Campbell Plateau Transect)

Mean depth: 563 m
Samples recovered: White, fine sandy foraminiferal ooze in GC-6 (5.45 m).

Site 9 is located on a very gently undulating seafloor. A moderately reflective and thinly bedded upper sequence, ~10 m thick, disconformably overlies a poorly reflective lower sequence that is at least 50 m thick. The seabed and unconformity both appear as strong horizons in the PARASOUND profile.

Site 10 (SW Campbell Plateau Transect)

Mean depth: 602 m
Samples recovered: ?glauconitic, fine sandy foraminiferal ooze in BX (0.2 m); silty foraminiferal ooze in GC-6 (2.25 m).

This site is located south of Campbell Island, on an undulating seafloor that slopes gently to the south-west. A moderately reflective and laminated upper sequence, 15-20 m thick, overlies a poorly reflective, almost transparent sub-sequence that is at least 20 m thick.

Site 11 (SW Campbell Plateau Transect)

Mean depth: 981 m
Samples recovered: Fine-medium foraminiferal sand in BX (0.18 m); 2 x GC-6 nil.

The area of the site slopes gently to south-west, and has a smooth surface. At least 5 m of flat-lying sediments are visible. Distinct horizons occur at 10, 18 and 28 m depths. The lower horizon is slightly cusp-shaped (convex up) at a wavelength of about 300 m and amplitude of 2 m. This slight deformation of the lower unit is thought to be due to compaction by the load of overlying beds.

Site 12 (SW Campbell Plateau Transect)

Mean depth: 1109 m
Samples recovered: 2 x BX nil, GC nil.

A very reflective (?hard) 6 m thick surface layer is present at the site. This layer is underlain by 30 m of thinly stratified beds, followed by at least 50 m of sediment with relatively thick beds (mean thickness ~10 m).

The strongly reflective surface layer is very distinctive. It rises (~15 m) to a local seafloor high several km south-west of the site and thickens to 35 m beneath the high. The upper part of this layer has bedding sub-parallel to the seafloor, but a prograding sequence, with individual beds up to 5 m thick, occurs towards its base. This reflective layer is interpreted to be a drift or debris fan containing relatively coarse sediments.

Site 13 (SW Campbell Plateau Transect)

Mean depth: 1685 m
Samples recovered: Medium-fine foraminiferal sand in BX(0.18 m); 2 x GC-6 nil.

PARASOUND indicates that the site is located on a rough sea bottom at the base of a steep slope. A volcanic cone, at least 150 m high, lies immediately to the south-west. Patches of relatively transparent sediment, 0-8 m thick, overly a strongly reflective (hard) layer that is of variable thickness, but averages about 15 m. Local bedrock lows/graben are additionally filled at depth by draped sediment, more than 50 m thick in places. The underlying bedrock surface is an angular unconformity; bedrock outcrops in places.

Site 14 (SW Campbell Plateau Transect)

Mean depth: 2075 m
Samples recovered: Few pebbles in BX.

Site 14 is located on a very rugged slope, with a 250 m scarp 5 km to the east. It is largely unsedimented, but with some patches of young sediment to ~5 m thick. These sediments are probably coarse, reworked foraminiferal sands, as at previous sites.

Site 15 (SW Campbell Plateau Transect)

Mean depth: 3000 m
Samples recovered: Mn-encrusted boulder (fresh ?dolerite) in BX, nil sediment.

This site is located mid-slope on the south-west margin of Campbell Plateau, on a south-east-facing slope, in an area of very high relief and rough seabed. The PARASOUND shows a hard bottom, often with numerous diffraction hyperbolae - indicating extreme roughness. There is no evidence of significant sub-bottom penetration, and no clear indication of young sediment at the surface. The PARASOUND shows apparent layering (to ~25 m) at low ship's speed, but this is probably an artefact produced by side-echoes off adjacent local topographic highs. A 250 m high ?volcanic cone is located 4 km to the south. In summary, this site is situated on a steep and rugged slope, devoid of sediment cover. The bare rock (?volcanic) surface has presumably been swept clear of sediment due the erosive effects of strong deep-water currents along this exposed tip of the SW Campbell Plateau.

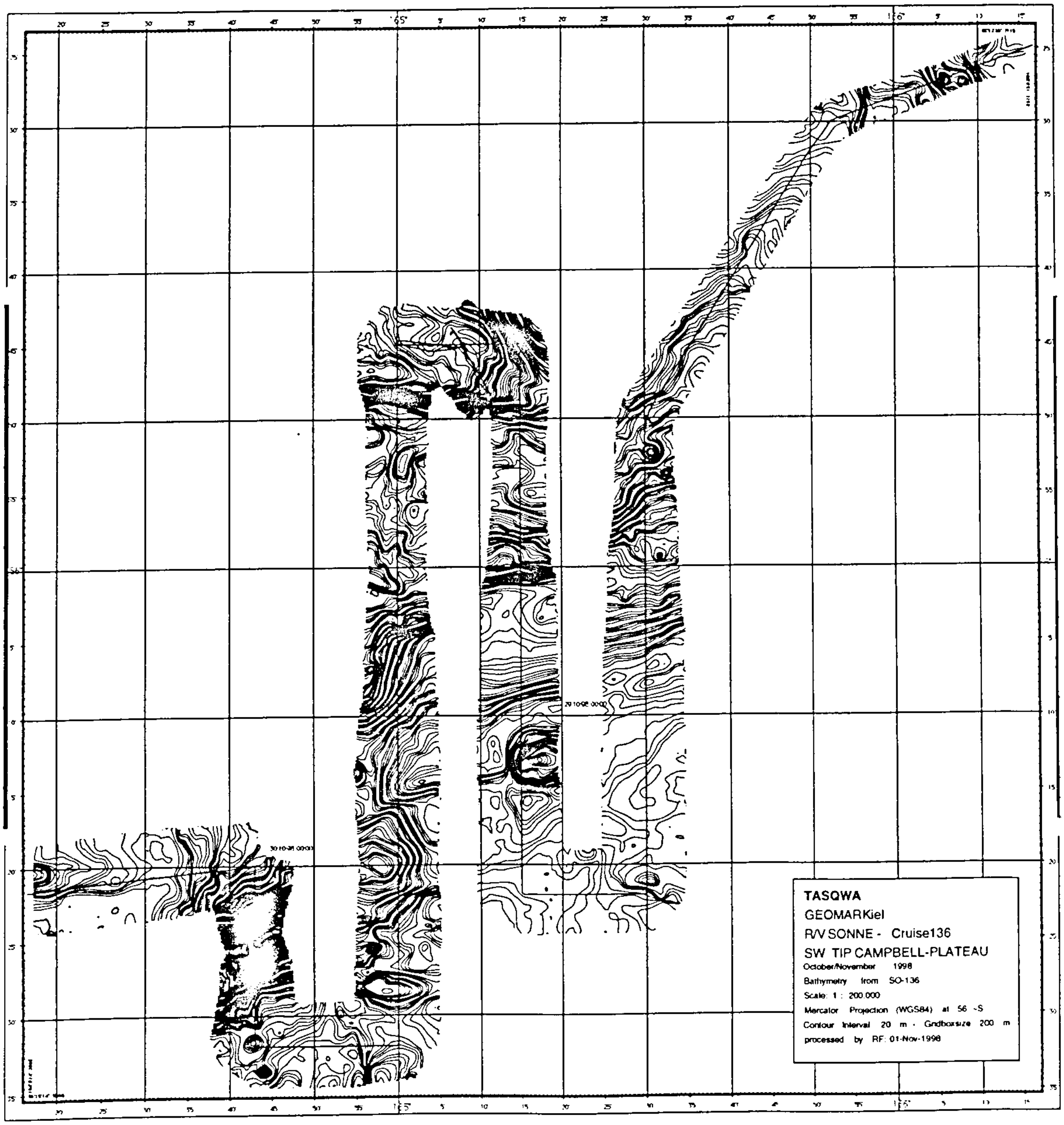

Fig. 6: Track of the HYDROSWEEP profile at the S Campbell Plateau showing the rugged bathymetric features.

Site 16 (SW Campbell Plateau Transect)

Mean depth: 4140 m
Samples recovered: In BX (0.34 m) fine foraminiferal sand containing disseminated black mineral grains (?derived from Mn-crust). GC-12 nil.

The lower continental slope, where this site is located, is steep, rugged and current-swept. The survey of several lines done in this area (Fig. 6) showed bedrock to be exposed almost everywhere in this region. Young sediment is present only in small localised and thin deposits. The HYDROSWEEP data show the terrain to be dominated by steep ENE-ESE trending ridges and scarps. These scarps are commonly more than 500 m high. A number of local highs, 200-700 m high, occur throughout the area, and probably represent volcanic cones.

The selected site is located within a V-shaped canyon bounded by 1200 m high cliffs to the north-east and south. It lies on a small local rise immediately downslope of the canyon head wall. The PARASOUND profiles show the surface of this rise to be relatively smooth, to be underlain by a thin (several metres thick) well-stratified surface layer. Some deeper internal stratification, including some offlap on the slopes is also suggested, but this may be the result of side echoes. The site's location and the sediment composition suggest that the sediments have slumped or flowed into the canyon from higher on the plateau margin.

Site 17 (Southern Emerald Basin)

Mean depth: 5010 m
Samples recovered: Foram-bearing siliceous diatom ooze in GC-12 (6.26 m); BX nil.

This site is located within a topographic low within the abyssal Emerald Basin. This low is bounded by 'fault' blocks that rise steeply more than several hundred metres above the enclosed flat-lying plain. This plain is floored by a wedge of pounded, well-stratified sediments that thins to the west and onlaps a 'bedrock' fault block to the east. This eastern side of the basin corresponds to a major regional N-S trending structure (?fracture zone), seen in satellite gravity imagery.

The site is located close to the middle of this plain, where the sediment wedge is ~45 m thick. Here the wedge comprises an 8 m thick transparent surface layer, 13 m of finely stratified sediment, followed by a lower, more coarsely stratified unit (~6 m thick beds). The unit beneath the basal unconformity shows some stratification and may comprise older deep-sea sediments or volcaniclastics.

Site 18 (Southern Emerald Basin)

Mean depth: 4240 m
Samples recovered: Water column sampling only.

Site 18 is situated ~18 km west of Site 17, within a region of elevated ?fault blocks. It lies over the steep (~4° slope) upper flank of one of these blocks. The PARASOUND shows no distinct internal structure within the blocks, however, a well-developed sedimentary stratification is present in the upper parts of these blocks. The sedimentary piles are more than 100 m thick in places, and are commonly highly stratified with wavy bedding, suggesting drape and/or current deposition. Offlap at the margins of these sedimentary units indicates erosion by deep-sea currents.

Site 19 (Southern Emerald Basin)

Mean depth: 3980 m
Samples recovered: Water column sampling only.
This site lies within a steep-sided, several hundred metres deep basement valley. A 35 m thick sediment lens lies in the bottom of the valley. This lens comprises two sequences: - an upper well- and uniformly stratified layer that is up to 20 m thick and a relatively opaque, thinly bedded, 15 m thick basal lens. The sediment surface undulates and has obviously been shaped by deep-sea currents.

Site 20 (Southern Emerald Basin)

Mean depth: 3906 m
Samples recovered: Diatom-radiolarian ooze in BX (0.34 m); foraminiferal-bearing diatom-radiolarian ooze to very siliceous clay in GC-12 (9.61 m).
This site is situated in an area of very rugged and blocky terrain in the central southern Emerald Basin. Locally-thick sediment drifts have accumulated on 'bedrock' blocks and within intervening topographic lows. These drifts are well and closely stratified, have a wavy geometry, show minor compaction faulting, onlap the 'bedrock' surface and show offlap (current erosion) where exposed on steeper slopes. As seen in the PARASOUND profiles, 'bedrock' is internally relatively structureless and transparent, with a sharp but low amplitude reflection character at the seabed and beneath the young drift deposits. This suggests a relatively soft rock or sediment - perhaps volcaniclastics or older deep-sea clays.

The sampling site lies on a 150 m thick well-stratified sediment drift. The seabed is gently undulating. The strata are uniformly spaced (~5 m), continuous and mostly parallel (but with some low-angle unconformities present). The shallowest sequence is 15-18 m thick, and appears slightly more reflective in the PARASOUND profiles than the underlying section.

Site 21 (Southern Emerald Basin)

Mean depth: 4460 m
Samples recovered: Terrigenous and foraminiferal -bearing siliceous ooze (radiolarians and diatoms) in BX (0.36 m) and GC-12 (10.69 m).
Site 21 is located about 100 km south-east of Macquarie Island and 65 km east of Macquarie Ridge. It lies on a sediment-capped 'basement/bedrock' block almost 200 m high. The sediment cap is at least 90 m thick, and the beds dip back gently and offlap at the edge of the block. The sediments are all well-stratified. The underlying 'basement/bedrock' appears relatively transparent and structureless, and where exposed on the flank of the block, shows no strong reflective character at the surface. This suggests that this unit comprises volcaniclastic or old deep-sea sediments, rather than hard igneous rock (e.g. basalt).

At the site, a reflective 10 m thick surface sequence overlies a 13 m thick less reflective sequence. This in turn, unconformably overlies a more thickly bedded unit.

Site 22 (South Tasman Rise Transect)

Mean depth: 3880 m
Samples recovered: Water column sampling only.

This site is located at the northern end of a major NNW-trending ridge adjacent to the Balleny Fracture Zone. The seabed topography at the site is of very high relief, with mar side-echoes in the PARASOUND profiles and no discernible sub-bottom penetration. The seabed is probably a rugged basalt terrain.

Site 23 (South Tasman Rise Transect)

Mean depth: 3935 m
Samples recovered: BX (0.40 m) foraminiferal sand, with Mn-nodules (mean diameter 5 cm) imbedded in the surface (60% areal coverage). GC-12 (7.77 m).

Site 23 is located about 40 km south-east of Site 22, east of the major ridge and on the WSW flank of an undulating rise. The site is a gentle incline several hundred metres above a 50 m high steep slope.

PARASOUND profiles show well-stratified sediments to about 100 m depth. The strat are undulating and represent drape sedimentation. The seabed surface is relatively smooth, sharp and strongly reflective. A surface layer, 10-18 m thick, also has a strongly reflective character and consists of a number of interbeds. The underlying section is wel stratified, with a number of strong horizons.

Site 24 (South Tasman Rise Transect)

Mean depth: 4035 m
Samples recovered: Nil in BX (corer slightly bent and Mn stained).

This site is located just east of the Balleny Fracture Zone, where underlying oceanic basement would be ~40 m.y. old. It lies in an area of moderate relief, where ?fault scarps and ridges are up to ~150 m high. Seabed structures show a NE structural trend, which appears to be superimposed on the regional E-W spreading fabric.

The undulating seabed in the area shows up very strongly in the PARASOUND profiles, and appears to be erosional. Weak, continuous to discontinuous reflectors can be seen in the sub-bottom, and these are visible to a depth of 100 m in places. The strata are generally sub-parallel to the seafloor. The site is situated in the bottom of depression (?small half-graben). The strata here show small-scale normal faulting that extends to the surface.

Site 25 (South Tasman Rise Transect)

Mean depth: 3384 m
Samples recovered: Water column sampling only.

Site 25 is located at the northern end of the large topographic high just to the south of the south-east tip of the South Tasman Rise. This large topographic feature may be a volcanic pile that forms part of the Balleny hot-spot chain, or it could be a block of extended continental crust that became detached from the South Tasman Rise during early seafloor spreading.

The terrain at the site is of high relief, and pinnacles in the profiles suggest volcanics. The site itself is situated towards the base of a 200 m high slope. A prominent unconformity underlies the upper part of this slope and the local high at the top of the slope. The relatively transparent and structureless sediment pile is 50 m thick beneath the high. It may be an accumulation of volcanic ash or a remnant pelagic sediment drift. The seafloor is very strongly reflective, probably due to a Mn layer - either crust or nodule pavement.

Site 26 (South Tasman Rise Transect)

Mean depth: 3023 m
Samples recovered: Well-sorted, fine foraminiferal sand in BX (0.22 m).

Site 26 lies mid-slope on the eastern side of the south-east tip of the South Tasman Rise. In the vicinity of the site, the seafloor has a slope of ~1.5° and a relief of tens of metres. This relief is largely due to local thickening and thinning of the surface sedimentary layer (mostly syndepositional but ?possibly some slumping), as well as gully incision on the slope. The surface sediment layer is 5-25 m thick. At the site, its thickness is 5-8 m.

Site 27 and 28 (South Tasman Rise Transect)

Mean depth: 1637 m
Samples recovered: Pale yellow, fine, well-sorted foraminiferal sand in BX (0.27 m).

This site lies near the crest of the south-east tip of the South Tasman Rise. The seabed here is generally smooth and flat or only of gentle slope. However, at least one small seamount (?Tertiary volcanic cone) rises above the sediment plain in the vicinity of the site.

Site 29 (South Tasman Rise Transect)

Mean depth: 1690 m
Samples recovered: Light grey/pale yellow fine-medium foraminiferal sand, well-sorted in BX (0.17 m).

Site 29 is on the western summit area of the south-east tip of the South Tasman Rise. The seabed at the site is smooth and slopes very gently to the west. Rugged basement outcrops to the west where the plateau surface drops steeply. The blanket of sediment at the site is ~ 20 m thick, and overlies a prominent basement unconformity. The sediments are only weakly stratified.

Site 30 (South Tasman Rise Transect)

Mean depth: 2178 m
Samples recovered: White, nannofossil/foraminiferal ooze in BX (0.18 m).

This site is located mid-slope on the southern margin of the South Tasman Rise. It coincides with RV MARION DUFRESNE piston core MD97-2108 (20.08 m recovery) and Site STR02A of the ODP Leg 189 drilling proposal.

A detailed HYDROSWEEP and PARASOUND survey of the site, with three crossings at different azimuths, was made. The HYDROSWEEP bathymetric contours and

PARASOUND profiles show that the area is of moderate relief, with a mean slope of 1.4° to the south-west. Steep slopes, 50-80 m high, are not uncommon; the highest escarpment in the area is 200 m high, runs N-S, and is 12 km east of Site 30. Down-slope gullies and small canyons, typically 30-60 m deep, occur throughout the area. The site is located on the eastern side of such a gully. This gully is at least 25 km long and runs N-S.

Up to 55 m of section is visible in the PARASOUND profiles. It consists of an upper reflective and well stratified sequence ~20 m thick, underlain by a more transparent unit with slightly wavy bedding which is 35 m thick at the site but which wedges out away from it. An eroded 'bedrock' surface with moderate relief is at its base. The gullies in the area have incised the sedimentary section.

Site 31a (South Tasman Rise Transect)

Mean depth: 1844 m
Samples recovered: Water column sampling only.

Site 31a lies on the upper slope of the South Tasman Rise, south-east of the summit area, and midway on the north-east margin of the rise. The area is of moderate to high relief, with volcanic terrain (including volcanic cones to 200 m high) just to the south, and a steep and rugged flank of the South Tasman Rise to the north-east. The site is on a small local high, truncated on one side by a 30 m scarp. About 15 m of young sedimentary section overlies eroded 'bedrock'.

Site 31b (South Tasman Rise Transect)

Mean depth: 1841 m
Samples recovered: Fine foraminiferal sand (with fine black grains) in BX (0.11 m); GC nil.

Site 31b is located about 2.5 km south of Site 31a. The young sedimentary section is thicker (~22 m) and more uniform here. A surface layer, several metres thick, is highly reflective. The underlying section has an indistinct wavy stratification, and is underlain by a rough erosional 'bedrock' unconformity.

Site 32 (South Tasman Rise Transect)

Mean depth: 3207 m
Samples recovered: Foraminiferal marl ooze / foraminiferal sand in GC-12 (7.56 m); BX nil.

This site is located on the lower eastern flank of the South Tasman Rise, directly east of the summit area. A number of large volcanic seamounts (?hot spot volcanoes) rises steeply from the adjacent abyssal plain of the L'Atalante Depression. The closest is about 10 km to the north.

A shallow depression about 7 km across, and with only 0-2 m of young sediment cover, lies between this volcano and the site. A local topographic and 'bedrock' high, with ~20 m relief, forms the southern margin of the depression. The site lies 1-1.5 km south of the high. The high may represent a small fault block or volcanic build-up. A reflective, 20 m thick and mostly poorly-stratified young sedimentary section underlies the site. It appears to be partly ponded against the high and partly draped on it. The top 7-8 m of the section comprises a sequence that is slightly more reflective and stratified. A strong horizon (?disconformity) occurs at the base of this young section. Sub-horizontally stratified sediments extend at least 40 m below this.

Site 33 (South Tasman Rise Transect)

Mean depth: 3685 m
Samples recovered: Foraminiferal ooze in GC-12 (8.80 m); coarse silty foraminiferal ooze in BX (0.38 m).

Site 33 lies on the lower slope of the north-east South Tasman Rise, about 20 km from three large volcanoes to the NNE-SW on the margin of the L'Atalante Depression. The surface at this site is undulating with relief of 10-15 m. The visible section extends to 70 m sub-bottom. The visible section comprises an upper sequence, which is fairly structureless and variable in thickness (0-15 m), a closely stratified intermediate sequence 12-15 m thick with slightly wavy bedding, and a lower relatively transparent unit with fine, but indistinct bedding.

Site 34 (South Tasman Rise Transect)

Mean depth: 3235 m
Samples recovered: Foraminiferal ooze in GC-12 (8.38 m).

This site is on the lower northern margin of the South Tasman Rise, on a gently-sloping plain that opens out onto the floor of the L'Atalante Depression. The area was swath-mapped by AGSO in 1994 using RV L'ATALANTE. The surface here has minor relief of less than 2 m. The section is not strongly stratified, and is moderately transparent. Unconformities are present at 12 m and 40 m sub-bottom.

Site 35 (South Tasman Rise Transect)

Mean depth: 4066 m
Samples recovered: Foraminiferal nannofossil bearing ooze in GC-12 (9.78 m); foraminiferal ooze in BX (0.46 m).

Site 35 coincides with proposed Site SET01A of ODP Leg 189. It lies in the north-west corner of the abyssal L'Atalante Depression. A Simrad EM12D swath- and GI-gun seismic line was run across it during AGSO's 1994 cruise on RV L'ATALANTE. A survey of two orthogonal HYDROSWEEP/PARASOUND lines was made during SO136 to provide additional site survey data for ODP.

The seafloor at the site has a very gentle slope and is very slightly undulating, with relief of only a few metres or less. The PARASOUND profiles show that the sedimentary section exceeds 150 m. It is well-stratified sub-horizontally, to at least 100 m depth. A number of sedimentary sequences can be distinguished, with the upper one being 30 m thick. The strata have been affected by minor compaction faulting, which has resulted in convex-up segments between faults and has produced the slightly undulating surface topography.

Site 36 (South Tasman Rise Transect)

Mean depth: 3990 m
Samples recovered: GC-12 bent, foraminiferal mud stain on bottom 2 m (nil core).

Site 36 is located at the base of the south-west East Tasman Plateau (northern L'Atalante Depression). The slope is gentle and the seabed is smooth.

Seabed-parallel strata extend to more than 60 m sub-bottom. The top layer is moderately reflective, 10 m thick and finely stratified. Underlying this is a 16 m thick sequence that is moderately-finely stratified. The deepest visible sequence appears more thickly stratified, with strata 3-10 m thick.

Site 37 (East Tasman Plateau)

Mean depth: 2870 m
Samples recovered: Water column sampling only.
Site 37 is located on the upper flank of East Tasman Plateau, west of Cascade Seamount. The seabed in the area is moderately steep and gullied. Visible sedimen thickness in the PARASOUND profiles is ~50 m. Stratification is wavy and sub-parall the seafloor. A moderately reflective upper sequence extends 10-20 m sub-bottom.

8.1.2 Sediment coring and high-resolution stratigraphy

Instruments used for geological sampling

(1) Gravity corer
mounted with a lead of 3 tons in weight. The main steel barrels are of 5.75 m lengt the inner plastic liners containing the sediment have a diametre of 125 mm. At most station one or two sections of the steel barrels was employed as "6" or "12" metre cor Only once a shortened barrel was used with a total length of 2.50 m.

(2) Box corer
the sampling box has an inner size of 50 x 50 x 50 centimetres; total weight of the corer is 850 kg. The single lid shovel closes the by penetrating the sediment sidewar when lifting the box corer from the sediment surface. The sampled material is protect against washing during heaving back on deck with two lids. In ideal conditions the sediment surface stays entirely intact.

(3) Multicorer
the total weight of the multicorer is 700 kg; it uses in total 8 plexi glass tubes with 9 centimetres in diameter and 50 centimetres in length. By penetrating the sediment surface very slowly any disturbance is limited to a minimum, which allows to retrieve almost in situ samples including the overlaying bottom water. The plexi glass tubes a closed with rubber sealed lids on both ends just before the start of heaving off the se floor. The multicorer naturally is a more fragile instrument which requires calm sea conditions. Due to the weather circumstances the multicorer was employed only few times during the TASQWA cruise.

(4) Epibenthos sledge
a gridded custom made steel frame with mounted plastic net and sampling bottle. lead weight of 500 kg was mounted to the wire at 200 m above the sledge to keep it the ground. Due to the low weight and fragile nature of the catching net winch speed had to be kept to a minimum. The epibenthos sledge was deployed several times in shallow to medium water depths on the Challenger Plateau and the Campbell Plate with always obtaining excellent results.

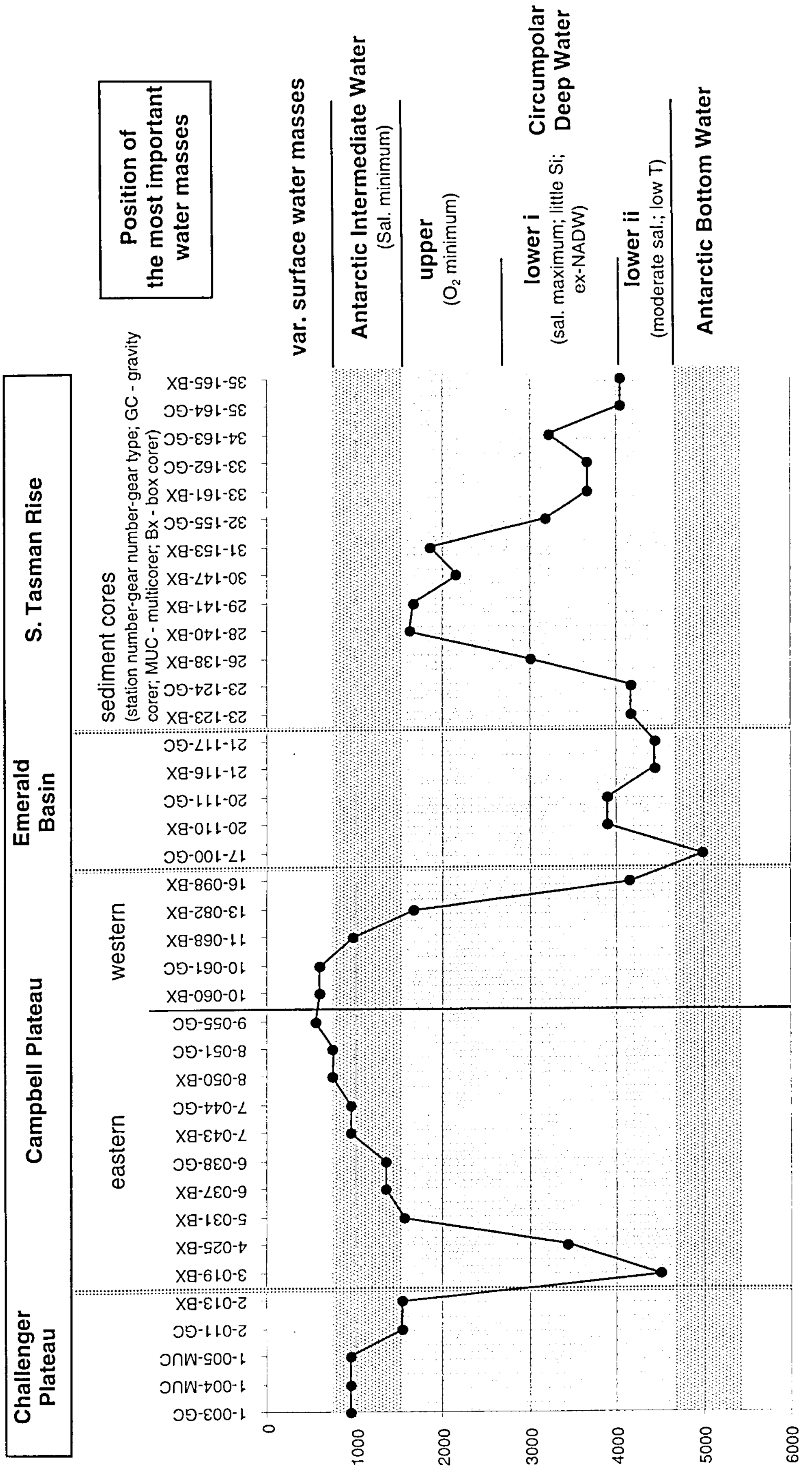

Fig. 7: The TASQWA sediment cores plotted vs. water depth and the potential subsurface water masses.

In general sampling was very successful (Figs. 7 and 8). At the first sites on the Challenger Plateau and the eastern Campbell Plateau we encountered no problems with all the employed gear. On the western Campbell Plateau the lack of appropriate sediments led to a damaged gravity corer tube. Nevertheless, at the box corer stations we obtained excellent samples in various water depths. At one station at the SW Campbell Plateau a 25 kg piece of rock was sampled with the box corer without any further sediment. This was a surprise since the echo sounder record was indicating a perfectly stratified sedimentary sequence. The steel box luckily was only slightly bent and no further damage to the box corer was detected. Coring in the Emerald Basin brought three long gravity cores and well recovered sediment surfaces in the box corers. Despite the great water depths and the uncertain nature of the sediments all sampling gear worked without any problem. The transect over the south Tasman Rise again showed little evidence for good coring sites. However, the box corer revealed surface samples in most cases, in particular when the gravity corer failed. It was suspected the sandy nature of the sediment was mainly responsible for that. At the northern edge of the South Tasman Rise several excellent gravity and box cores were retrieved during the last days of the cruise from great water depths of around 4000 m.

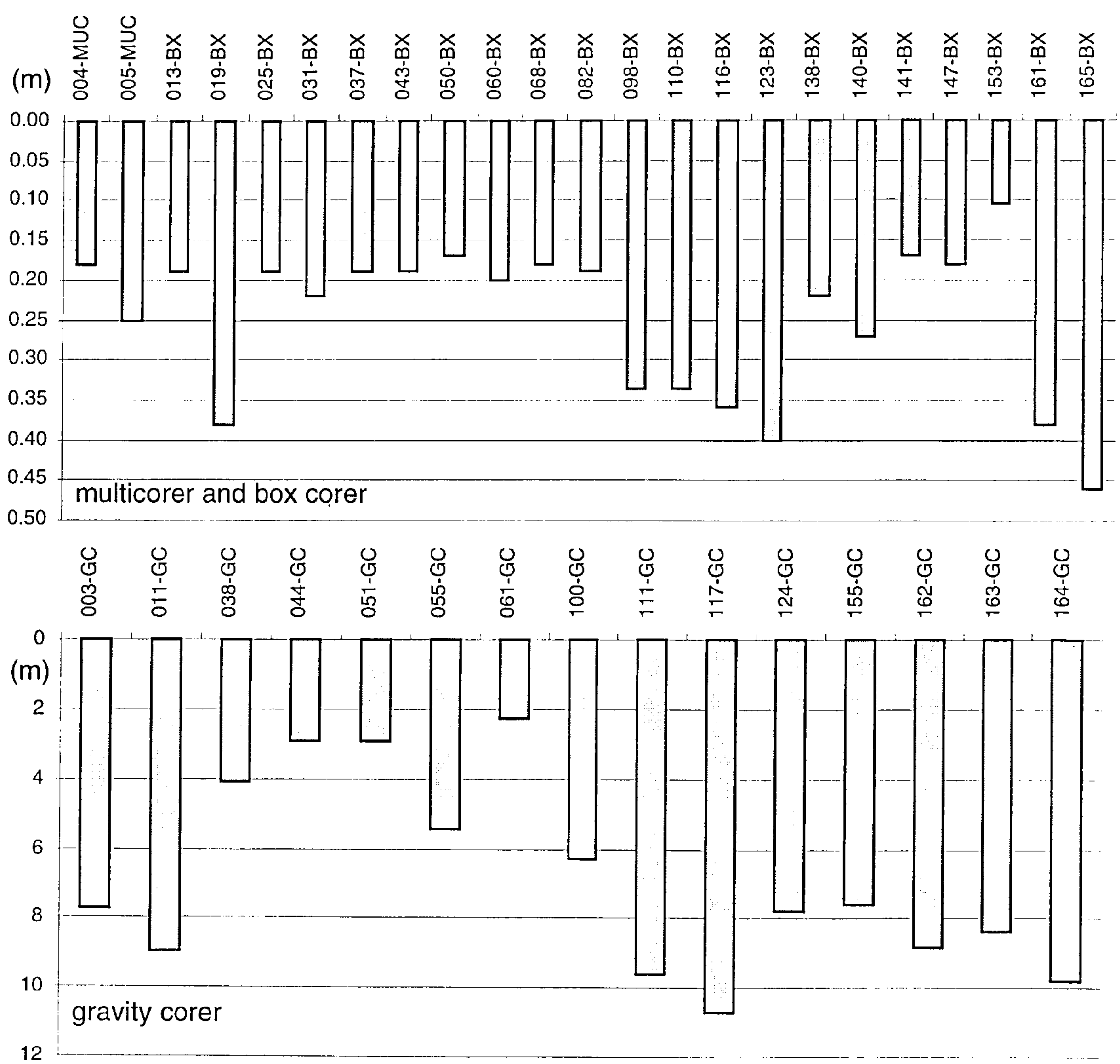

Fig. 8: The long and short TASQWA sediment cores plotted vs. recovery.

Rough weather conditions with in particular high swell often made work on deck difficult, sometimes even dangerous. Occasionally sailors and technicians had to be secured with ropes. It is only thanks to the good work of the boatswain and his crew that geological sampling could be completed successfully.

Physical properties

Shipboard physical properties measurements were made using a track-mounted GEOTEK Multisensor Core Logger, including the following sensors:

1) Gamma-ray attenuation porosity evaluator ("GRAPE") for wet bulk-density estimates;
2) P-wave logger (PWL) for acoustic velocity estimates;
3) Magnetic susceptibility.

Methods

The sections are passed individually through the Multisensor Track (MST) on a “boat” rather than being “pushed” through the system in contact (or "butted") against each other. The advantage of this configuration is that very watery sediment is not lost through the section ends. One disadvantage is that the "butt error" in section length, and in cumulative downcore depth is potentially greater. We have corrected for this effect by manually positioning the top end of each section at the beginning of the cut section, at the reference point, and by manually setting the initial pusher position for each section at the measured length of the section including end caps. However, some small offsets and values that are measured beyond completely full liner may still exist; these will be further corrected post-cruise. In particular, values at the bottom 20-30 cm of gravity cores may be affected by void space left after removal of the core catcher. An estimate of the possible cumulative error introduced by the end caps can be seen for each core in the “section log” sheet of each core spreadsheet. Another disadvantage of pushing the sections through individually is that magnetic susceptibility drops off at the beginning and end of each section because of the “proximity” of air. Though we have reported the raw susceptibility values, a correction for the end effect can be made in post-cruise processing. A 20 m calibration section was run at the beginning (and in some cases at the end) of each core MST run.

The P-wave logger uses two piston-type 500 kHz transducers to measure the velocity of compressional waves through the core perpendicular to its long axis. The measurements were taken every 2 cm, and water was sprayed on the core to maintain continuous acoustic coupling between the transducers through the core and liner, and the acoustic waveform was continually monitored on an oscilloscope to evaluate the quality of the P-wave data. The cores were allowed to equilibrate with the temperature in the MST lab for at least 2-3 hours to minimise the effect of temperature variations during the runs on the downcore P-wave measurements. However, core temperature was continually monitored during P-wave logging by means of a platinum resistance thermistor and velocity estimates take temperature into account. Because the end caps were left taped to the core section ends intact, approximately 4-6 cm of PWL data at each section end are usually of poor quality (as indicated by low P-wave amplitudes), and these points were rejected. In addition, some spurious values occur in packed clay intervals (especially in Cores SO136-100GC and 124GC) where sediments “washed” (see particularly the top 2.5 m or SO136-011GC). Most aberrant data points like these have not been plotted and are removed or set aside as “rejected.”

Core thickness is also monitored by means of displacement transducers on the P-wave transducer mountings: both P-wave velocity and GRAPE bulk density estimates allow fo variations in core section thickness.

The GRAPE system uses attenuated gamma-ray counts from a ^{137}Cs source to estima wet bulk density. In most cores GRAPE was measured at 2 cm intervals, though in the first few gravity cores software problems with GRAPE logging required us to push the core through "manually" and both trigger and read gamma counts. These measuremen were made at 4 cm intervals. Our initial calibrations and measurements were made wit 2-second gamma count integrations, later increased to 5 seconds for most of the data reported here (see Appendix A80 and A81).

The initial software problems with GRAPE logging (the computer would neither trigge nor log counts) required us to produce an independent GRAPE data set, and a separat calibration. An interim software fix allowed the software to trigger the counts so that we could read them from the board-mounted LCD as the core went through; these were made at the exact intervals the other measurements were made and were easier to integrate after logging. We carried out three calibrations of the GRAPE system using varying thicknesses of aluminium plates. The calibration data are included in the data Appendix (A80 and A81). Successive calibrations were extremely stable and repeatabl Bulk densities are reported as wet bulk densities and are not corrected for the presence of water, though corrections of this type can be made (Boyce 1976).

Magnetic susceptibility (MS) measurements were made at 2 cm intervals using a Bartington Instrument loop sensor with a 16 cm inside diameter, with an integration time set to 10 seconds. The sensor was turned on at least half an hour before logging was begun to allow it to equilibrate, and the sensor was zeroed at the beginning of each cor logging run. MS data are reported as raw values in SI units. Only in a few runs was drift during the time of runs significant enough to warrant correcting (SO136-155GC for example).

Results

Challenger Plateau

Cores SO136-003GC and SO136-011GC

Both these sites had consistently low and relatively flat MS signals. Core SO136-003GC had very "clean" consistent GRAPE and P-wave velocity (PWV) signals. A disturbed top approx. 2.5 m of sediment in Core SO136-011GC affected both GRAPE and PWV signals; below 2.5 m the GRAPE signal is flat. We did not attempt any correlations between these cores for that reason.

Campbell Plateau

Cores SO136-038GC, SO136-044GC, SO136-051GC, SO136-055GC and SO136-061GC

All these cores had noisy PWV signals, and flat MS signals. Cores SO136-051GC and SO136-055GC had very noisy PWV records as well as disturbances in the GRAPE records. In some cases the MST data anomalies turned out to be significant core disturbances such as washed sections (see 055GC for example). In this area such anomalies made reliable and systematic intercore correlation rather difficult. The low amplitude of MS signals similarly made them difficult to correlate. The only core in this transect with a clean set of signals was SO136-061GC (South Campbell Plateau); there are possible correlations with SO136-044GC (East Campbell Plateau) on the basis of the GRAPE and MS data, between SO136-061GC and the upper approx. 1.5 m at SO136-044GC.

Emerald Basin

Cores SO136-100GC, SO136-111GC and SO136-117GC

This area yielded high-amplitude correlative signals between SO136-111GC and SO136-117GC, on the basis of GRAPE and MS data (Fig. 9). The upper approx. 3.2 metres of 100GC may be similarly correlative, but a dense clay layer below this depth in this very deep core (5009 m) makes the MST signals nearly flat (note the steadily increasing GRAPE values in this interval probably due to simple compaction). In SO136-111GC and SO136-117GC the character of the GRAPE and MS signals, and to some extent the PWV, form coherent structures that are correlative with each other, and

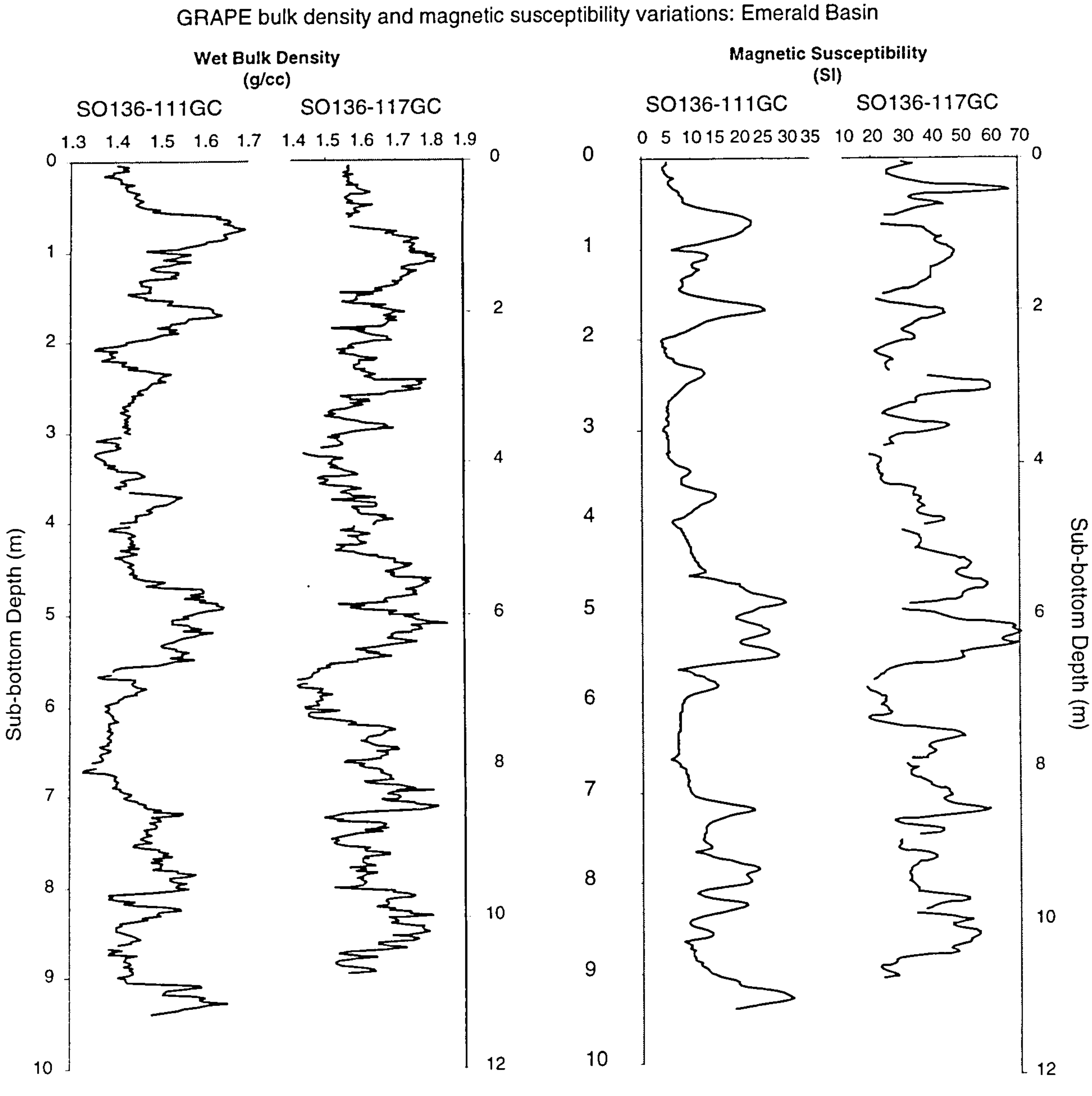

Fig. 9: Correlation of GRAPE data of cores SO136-111GC and SO136-117GC.

possibly with lithologic variations in other Southern Ocean cores which already have chronological control by oxygen isotopes, biostratigraphy and ^{14}C. In particular the high correlation between GRAPE and MS in both cores, and with colour reflectance, sugges similar lithologic control on all three. Specifically, high GRAPE corresponds to high MS Our initial interpretation is that low-GRAPE, low-MS intervals are intervals of high biogenic silica burial and relatively low input of detrital sediment, and these alternate with low-biogenic silica interval with greater detrital input (some combination of aeoliar dust and/or IRD). In other Southern Ocean sites, this mode of variability has a clear glacial-interglacial pattern: sites near the modern Polar Front show glacial decreases ir biogenic burial flux with greater detrital input. The similarities among the MST records i SO136-111GC and the % $CaCO_3$ and magnetic susceptibility records provides the tantalising possibility of correlating signals between the Emerald Basin and Southeast Indian Ocean cores like RC11-120. Fig. 10 shows SO136-111GC GRAPE and MS data plotted as a function of depth along with carbonate and MS (expressed as dust flux) in RC11-120 [data from Kent (1982) for RC11-120 and Petit *et al.* (1990) for the Vostok ice core, and RC11-120 chronology following Martinson *et al.* (1987) and Howard & Prell (1994)].

South Tasman Rise

Cores SO136-124GC, SO136-155GC and SO136-162GC

Magnetic susceptibility signals in the South Tasman Rise cores were low-amplitude though some coherent structure appears to be preserved in cores SO136-155GC and SO136-164GC. Drift in the MS sensor required us to correct the MS values in cores SO136-155GC, SO136-163GC and SO136-164GC. We made a correction by running distilled water standards at the beginning (always done in any case) and end of each r where drift appeared to be significant. By tracking the time at which the standard and core sections were run we could apply a simple correction, assuming the drift was line through the course of the run. The raw and corrected values, and drift corrections are given in the working spreadsheets in the Appendix (A80 and A81). GRAPE records in these sites, though low-amplitude, will probably prove the most useful signals for correlation, as they are likely to track variations in carbonate and clay proportions downcore. Correlative structure appears in the top 3 m of SO136-155GC (above a distinct sand layer that breaks up any continuous stratigraphy) and in the other three gravity cores from the South Tasman Rise transect.

Though we do not have complete shipboard biostratigraphy yet, my inspection of th core catchers in cores SO136-155GC, SO136-162GC and SO136-163GC for the presence of the planktic foraminifer *Globorotalia crassiformis*, revealed its absence in SO136-155GC, and presence in SO136-162GC and SO136-163GC. The regional LA of this species in subantarctic waters marks the top of Marine Isotope Stage 9 at about 300,000 y BP (Howard & Prell 1992 and references therein).

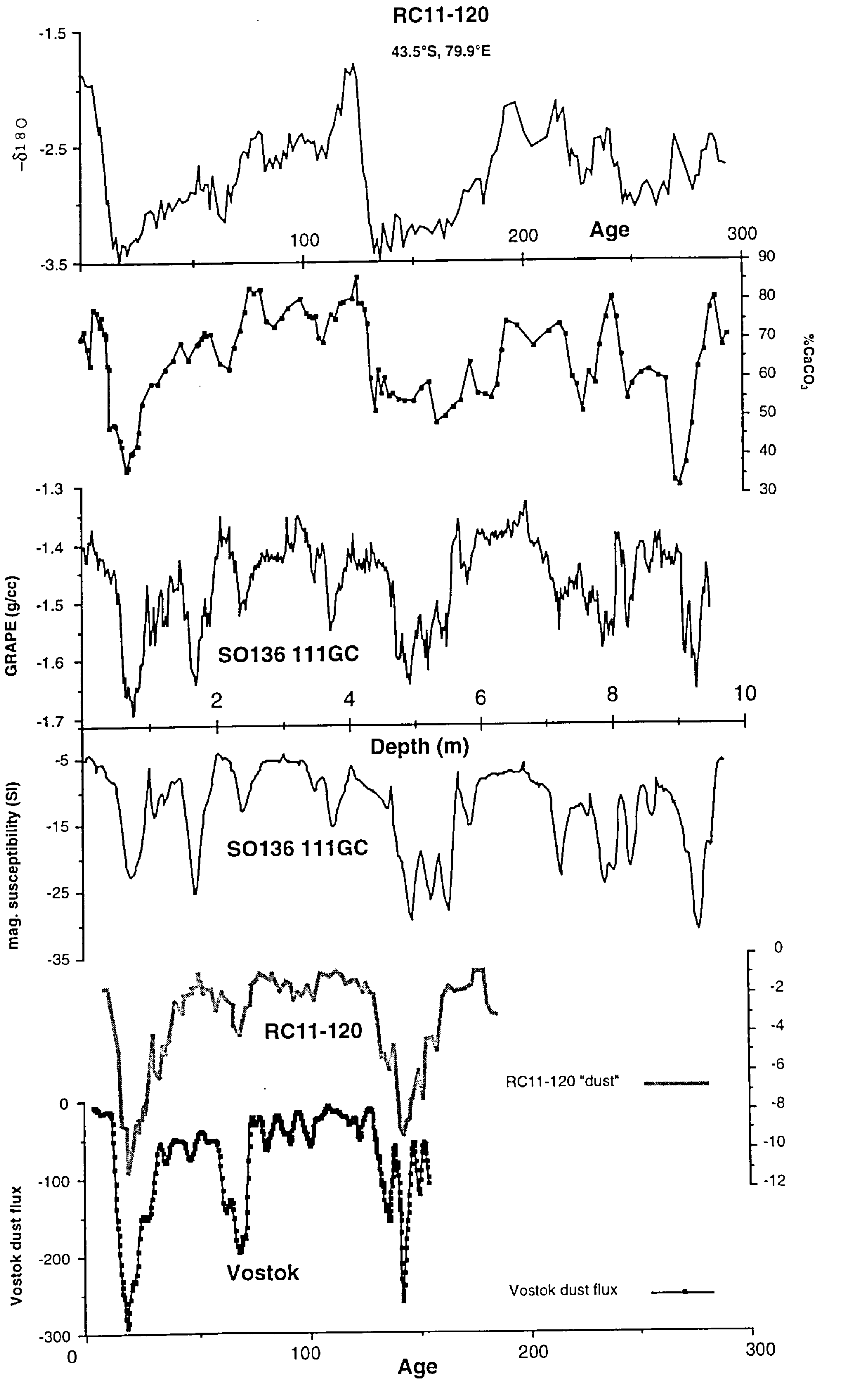

Fig. 10: Correlation of various palaeo-proxies and logging data of Core SO136-111GC.

Colourimetry

A spectral photometer CM 2002 from Minolta was deployed, to achieve optical data of the sediment in the wavelength range of 400 nm to 700 nm (visible light). Directly after the visual core description, the working halves of the taken cores were analysed. To protect the camera, being polluted by sediment, the core halves were covered by transparent plastic foil, which made a sampling in the SCE-Mode (Specular Component Excluded) necessary. The measurement area of the spectrophotometer is Ø8 mm. To achieve the highest possible resolution, a sampling distance of 1 cm was taken throughout the analysed cores. The Minolta was calibrated with black and a white standard before every new core measurement, occasionally in between the sections, whenever the time-distances extended to more than an hour.

Measuring principle

The CM 2002 (Minolta) is equipped with a pulsed xenon arc lamp, which illuminates the integrating sphere of the spectrophotometer. Diffusely backscattered, the light hits the target, becomes reflected and is focused on a silicon photodiode. The reflectance-intensity of a wavelength range of 400 nm - 700 nm (in 10 nm pitches), L* a* b* values and data of the Munsell Colour System are detected by this sensor. The camera was connected on-line to a Macintosh LC computer, where the data were stored and analysed afterwards. The CM 2002 inserted several zero-measurements throughout the cores without a detectable reason. In order to get the correct values for the distinct core-depths, these zero-measurements had to be removed before plotting the data.

To achieve some information concerning glacial/interglacial changes, the 400 nm values and 700 nm values, respectively were plotted versus the core depth (Fig. 11 and Appendix A31 - A33).

The data were not processed furthermore for the plots in the Appendix. The graphs displayed in the results section were smoothened by using a five-point running average.

Results

Cores from 3 different working areas of the SO136-cruise to the Tasman Sea and the Southern Ocean are shown in this section. These are the cores SO136-038GC, SO136-044GC, SO136-051GC (SO136-055GC, disturbed) from the eastern Campbell Plateau, cores SO136-111GC and SO136-117GC out of the deep Emerald Basin, and two cores (SO136-124GC and SO136-155GC) from the Tasman Rise. The cores from the Challenger Plateau did not show any useful colour changes, and therefore are not plotted and discussed herein.

Reflectance curves of sediments can show quite similar trends like seen in the oxygen isotope curve. The trend of the red and blue reflection curves is controlled by the same parameters, that create different kinds of sediment colour. Light, carbonate rich sediments from interglacials lead to a higher reflectance than dark, silica-rich sediments from glacial periods. Moreover the density of the observed sediment has an influence on its spectral reflectance.

The 700 nm values for these cores were taken for plotting against depths, because the blue spectrum of the visible light showed higher amplitude changes throughout the cores. Therefore a better resolution could be achieved to establish a first stratigraphy. Although one could use these first preliminary results on dividing the cores into isotope stages, it has to be kept in mind, that this is only a rough estimate, and has to be cross-checked with the nannofossil ages, which the scientific party of SO136 is still working on. Some first cross-checks have been achieved to the nannofossil stratigraphy and to the MST logging crew, which are at that very moment in good agreement. Later on, a final oxygen isotope analysis may possibly lead to a correction of the subdivisions and their interpretations.

From the cores mentioned above, it is assumed that the oldest sediments cored on the TASQWA-Cruise originate from the late isotope stage 12 or early stage 13 (Core SO136-124GC from the southern Tasman Rise). Stages 1 to 3 might be missing in a few cores.

Campell Plateau

Four cores were taken in the E Campbell Plateau, from which one (SO136-055GC) was partly destroyed/disturbed by physical influence (storm) and therefore was not taken into account when making any conclusions for this area.

The cores displayed in Fig. 11 represent a depth transect from around 1359 m waterdepth (SO136-038GC) to 563 m waterdepth (SO136-055GC). The cores seem to represent a more or less constant sedimentation from the late stage 8 to the Holocene. In Core SO136-038GC the first peak can also represent stage 3, a feature that is already well known from the southern Ocean (pers. comm. Will Howard). As there was no similar trend in one of the other cores detected, we decided to account this peak into isotope stage 5.

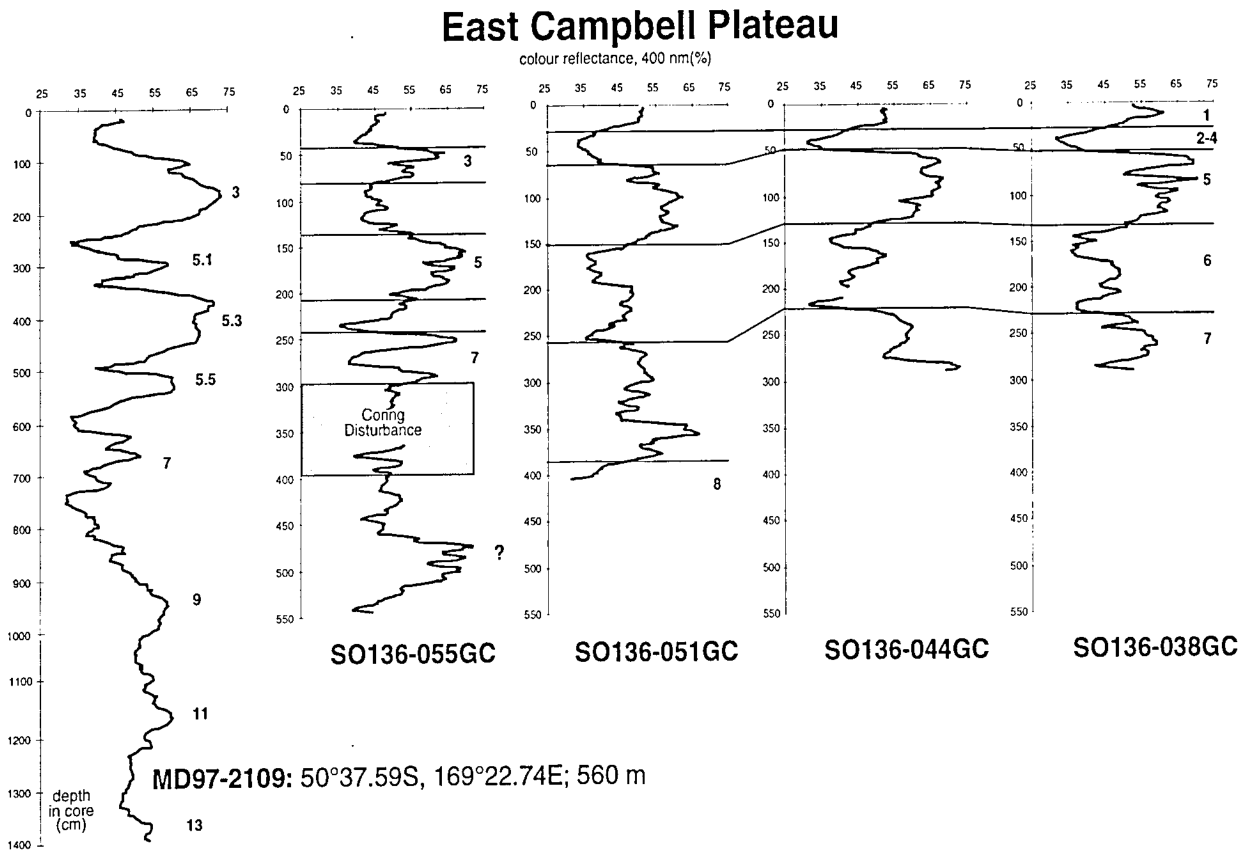

Fig. 11: Cross-correlation of spectral data of E Campbell cores.

Emerald Basin

The two cores from the Emerald Basin (Appendix A32) show considerably more small scale variations within the isotopic substages, when compared to the records of the Campbell Plateau. Especially interglacial stages 5 and 7 seem to be quite extended with much more colour changes within this stages (SO136-111GC). This may be due to the mixture of terrigeneous-silicious and biogenic-silicious as well as carbonatic sediments at this core location.

The cores shown here display at least a continuos record down to late stage 8. Core SO136-117GC is believed to show a sedimentation down to stage 9 or 10, but this is very uncertain. It has to be cross-checked with nannofossil ages.

South Tasman Rise

The sediment Cores SO136-124GC and SO136-155GC are believed to show a sediment record at least down to stage 11 or 12. The existence of manganese nodule horizons throughout Core SO136-124GC implies that sedimentation rates must have been very low in certain time intervals, what may proof the preliminary stratigraphy using the colour reflectance. Also the time interval between stage 2 and 4 show nearly no amplitudes. This might be due to a slump or any other sedimentological event. In contrast stage 5 shows the typical 3 peaks known from the isotope stratigraphy.

In Core SO136-155GC a good resolution can be found from stage 6 to the Holocene. Downcore from stage 6/7 boundary the record becomes very unclear, possibly due to the existence of an extended sandy layer from around 3 m downcore. This part could represent a hiatus or an erosion event, which cannot be clearly solved by using the colour reflectance.

Lithostratigraphy

The sediment classification of the cores follows Berger (1974). The digitised log-sheets of the visual core descriptions are documented in the Appendix. The sediment classifications are based on visual examination on board. A reliable stratigraphic correlation between the cores was not possible due to the great variability of sediment types and missing evidence of stratigraphic markers.

Challenger Plateau

The cores show a relatively monotonous lithology. The sediment consists of silty foraminiferal ooze to foraminifers bearing clayey silt. The major grain-size of the sediment lies within the fine silt fraction including some medium sand sized grains. Black angular clasts were recognised. Whether these clasts are charcoal or volcanic glass could not be determined. Major variations are the changing intensity of bioturbation and the sediment colour. Two types of bioturbation are present: (1) large burrows filled with sediment with a different colour and (2) small *Planolites* burrows with a clear layer parallel to bedding orientation, a preferentially horizontal orientation. Sediment colour changes from light greenish grey to greenish grey and very dark grey . Black pyrite streaks frequently occur. Some charcoal pieces as well as echinoderm spines were found. All together the cores are characterised by subtle lithologic variations with some distinct burrowing features and colour variations.

East Campbell Plateau

The sediments recovered are marl oozes with changing percentages of very fine to medium foraminiferal sand. Most of the sediments are intensively bioturbated. In the shallowest cores very well preserved burrows were found. The sediments of the deeper cores are heavily bioturbated and show only vague boundaries that are related to bioturbation intensities and colour changes. Colours change from white and pale yellow to pale olive. The box core sediments consist of foraminiferal oozes with high quartz contents and foraminiferal sands, well sorted silt to coarse sands. Blackened foraminifers, angular fine sand clasts (volcanic glass?). Dropstones with manganese crusts were in found occasionally. Colour changes from light olive brown to light brownish grey in the deeper water box cores, from white to light greenish grey in the shallower box cores. Bioturbation intensities vary throughout the sediments of the box cores.

South Campbell Plateau

Only one gravity core was successful in retrieving sediments. The sediments in this core are comprised of coarse silty foraminiferal ooze to fine sandy foraminiferal ooze and are heavily bioturbated. Colours vary between various shades of white and grey to light greenish grey and greenish grey. Black streaks do occur. The main coarse components are planktic foraminifers and some black angular grains (glauconite or pyrite?). Bioturbated firmgrounds occur at various levels within the core. The sediments from box cores are composed of very well sorted foraminiferal sands with some glauconite and pyrite. They are heavily bioturbated except for the upper 2-4 cm in which usually clear signs of recent current induced sediment transport could be observed (small-scale current ripples).

Emerald Basin

In comparison to the previous sites the type of sediment recovered in the Emerald Basin is completely different. It consists mainly of siliceous oozes with a series of diatom intercalations. The lower parts of the cores are composed of well burrowed hemipelagic clays. Some slight changes can be seen in burrowing intensification (mottling) that are associated with increased pyrite appearance. The sediment colours change between various shades of grey to brown and dark reddish grey. Few foraminifers are present in the upper 3 metres of very fine sand fraction. The most remarkable feature are the white to grey diatom intervals that seem to be made up of papersheet thin algal mats.

South Tasman Rise

The first core recovered on the South Tasman Rise showed a series of Mn dominated siliceous clays. Mn-nodules were found at various levels within the core. The overall grainsize decreases downcore from a medium sand to coarse silt. Mn-granules as well as radiolarians (up to medium sand size) were present throughout the entire core. Quartz was present in minor amounts. Colour changes between light grey and dark brown with black Mn-nodules. Bioturbation varied from moderate to intensive. Between 6.84 and

7.03 m a level with pink coloured clays and parallel burrowed layers (*Zoophycus* type?) were found. Core SO136-155GC consists of a series of foram-bearing marl ooze with an intercalation at 3.04-5.62 m of well sorted very fine- to medium-sand sized foraminiferal sand. The lower boundary of this fining upward interval is erosive. Below this interval, 5.62-7.56 m, a coarsening upward cycle is present which ranges from foraminiferal marl ooze to medium-sand sized foram-bearing sandy silt. Colour changes between light grey to pale yellow and white for the oozes, and white to light grey for the foraminiferal sand. Within the oozes intervals with laminations or fine streaks were observed with pale red to reddish grey, and greenish colours. These coloured laminations and streaks are probably of diagenetic origin. Angular silt-sized pyrite-, manganese-, and glauconite grains were found throughout the entire core. Bioturbation was poor to moderate. The last cores along the northern S Tasman Rise couldn't be opened due to time constraints.

The sediments retrieved in the box cores varied from manganese rich foraminiferal sand to well sorted foraminiferal sand and coarse silty foraminiferal ooze (SO136-161BX). Bioturbation intensities varied throughout the different lithologies from poor within the sands to heavily within the oozes. Colours varied between very pale brown and white. Some current ripples were found in the foraminiferal sands.

Biostratigraphy

Objectives

1. Biostratigraphic dating of all cores including surface sediment samples from box cores and multi-corers, and top and bottom of gravity cores based on calcareous nannoplankton.

Calcareous nannoplankton provides a reliable dating method for deep-sea sediments. They are of particular importance for the Quaternary with biostratigraphic datum events as follows (Thierstein *et al.* 1977; Weaver 1993):

73 ka	reversal of dominance by *Gephyrocapsa muellerae* in stage 5 to *Emiliania huxleyi* in stage 4.
200 ka	small *Gephyrocapsa* spp. zone (stage 7)
250 ka	first appearance of *Emiliania huxleyi* (boundary of stage 7/8)
250 ka	domination of *Gephyrocapsa caribbeanica* (Stages 8 to 12)
458 ka	Last appearance of *Pseudoemiliania lacunosa* (boundary between stages 12/13)

Smear slides of sediment samples were prepared on board and examined using a light microscope at x1000 magnification. Where there is an obvious change between the surface and base sediments of box cores, a second sample was taken from the base.

2. Quaternary palaeoceanography of the Tasman Sea south of Australia using calcareous nannoplankton as the proxy.

High resolution sampling at 5 cm intervals will be carried out on three cores, one from the Campbell Plateau and two from the South Tasman Rise, to determine the palaeoceanography of the region. Examination and interpretation of samples will be carried out on shore.

Results

Excessive vibration due to motors and general movement of the ship result in constant automatic changes to focus and preclude precise biostratigraphic interpretation relating to smaller species of nannoplankton. For example, coccoliths of *G. muellerae* and *E. huxleyi* are very similar in shape and size (approximately 4 to 5 µm). Distinction between the two species is found by the presence of a central bridge structure on *G. muellerae*, identified by the rotation of the stage. Constant adjustment of the fine focus to counteract the ships movements coupled with simultaneous rotation of the stage to identify the bridge structure is very difficult. Consequently, the following biostratigraphic interpretations are tentative only.

Challenger Plateau

Site 1, Gravity core SO136-003GC; 0-1 cm; *E. huxleyi* dominant - ?Stage 1 to 3.
Nannofossils abundant.
Base of core: 769-770 cm
Possibly *E. huxleyi* absent. *G. caribbeanica* acme. No *P. lacunosa* . Stage 8 to 12.

Multi core SO136-004MUC; 0-1 cm; Nannofossils abundant. *E. huxleyi* majority. Stage 1 to 3?

Site 2; Gravity core SO136-011GC; 0-1 cm; Nannofossils abundant. Possibly *E. huxleyi* majority. Stage 1 to 3.
Base of core: 876-878 cm; Nannofossils abundant. *G. muellerae* majority. No *P. lacunosa* ? Stage 5 or 6?

Box core SO136-013BX; 0-1 cm; Nannofossils abundant. Possibly *E. huxleyi* majority. Stage 1 to 3.

East Campbell Plateau

Site 3; Box core - SO136-019BX; 0-1 cm; Abundant quartz. Carbonate very dissolved. Nannofossils are rare, Mostly *C. leptoporus* (small and dissolved). Age?

Site 4; Box core - SO136-025BX; core top: 0-1 cm; Dissolved. Abundant quartz. Nannofossils present but not common. Age?
Base of core: 12-13 cm; Strong colour change between top and bottom of core. No carbonate particles at all. Abundant siliceous material. Mostly diatoms.

Site 5; Box core SO136-031BX; 0-1 cm; Very coarse sand from extensive winowing. Mostly foraminiferal pieces. Few Nannofossils. ?bryozoan/diatoms. Age?
19-20 cm; Highly dissolved. Very few nannos. Mostly foraminiferal pieces. Age?

Site 6; Box core SO136-37BX; 0-1 cm; Preservation good. Majority *E. huxleyi*? Stage 1 to 3?
Gravity core SO136-038GC; core top: 0-1 cm; Very fine carbonate material. No quartz. Very few large Nannofossils. No *C. pelagicus*. Possibly *E. huxleyi* majority? Stage 1 to 3?
Base of core: 407 cm; very fine carbonate material. Possibly small *Geyphrocapsa* zone? Stage 7? No *P. lacunosa* - younger than Stage 13. Dissolution evident.

Site 7; Box core SO136-043BX; 0-1 cm; *E. huxleyi* abundant? Stage 1 to 3?
Gravity core SO136-044; 0-1 cm; Extensive dissolution. Very fine carbonate material. Nannofossils are very rare. ?Stage; 150-151 cm.; *G. caribbeanica* acme. *G. muellerae* abundant. No *P. lacunosa.* Stage 8 to 12.; Base of core: 290-291 cm ; Dissolution evident. *G. caribbeanica* dominant. *G. muellerae* abundant. ?No *E. huxleyi.* No. *P. lacunosa.* Probably stage 8 to 12.

Site 8; Box core SO136-050BX; 0-1 cm; Dissolution moderate. *G. muellerae/E. huxleyi* abundant. Most likely stage 1 to 3, Possibly Stage 5 to7.;
Gravity core SO136-051GC; 0-1 cm; Preservation poor. Material is very dissolved. *E. huxleyi* and *G. muellerae* present. Stage 1 to 5?; Base of core: 289-290 cm.; Preservation moderate. *G. muellerae* majority. Stage 4 to 6?

Site 9; Box core SO136-054BX; 0-1 cm; Preservation moderate. *E. huxleyi* majority. Stage 1 to 3?
Gravity core SO136-055BX; 0-1 cm; Preservation poor. *E. huxleyi* present. Stage 1 to 5? Base of core: 545 cm; preservation good. *G. caribbeanica* majority. No *P. lacunosa.* Stage 8 to 12.

South Campbell Plateau

Site 10; Box core SO136-060BX; 0-1 cm; Very dissolved. Few nannoplankton. *E. huxleyi* present. Stage 1 to 7? Most likely stage 1 to 3.
Base of core 20-21 cm; Very dissolved. *G. muellerae* present. Stage 4 to 6?
Gravity core SO136-061GC; 0-1 cm; Preservation very poor. All small nannos (*E. huxleyi* and *G. muellerae*) gone. Age?; Base of core: 225 cm; Preservation moderate. Nannos are few. Possibly ?*E. huxleyi.* Older than Stage 3,

Site 11; Box core SO136-068BX; *E. huxleyi* abundant. Stage 1 to 3?

Site 12; Box core SO136-076BX; ?core top: 0-1 cm
Note: Site 12 is mostly foraminiferal sand. Box core washed out on retrieval. Remaining 2 cm of sediment in box core may not be core top.

Site 13; Box core SO136-82BX; 0-1 cm; Very coarse, clean white foraminiferal sand. Preservation of $CaCO_3$ is good although nannos very rare. Age?

Emerald Basin

Site 16; Box core SO136-098BX; 0-1 cm; Coarse, clean white foraminiferal sand with minor clay component. Although preservation of $CaCO_3$ is good, Nannofossils are rare. Age?

8.1.3 Microfossils and Late Quaternary palaeoceanography

Late Quaternary position of the lysocline and stable isotopes

Most sediment cores, which have a sufficiently high carbonate concentration, provide a unique climatically influenced signature. On the basis of the carbonate curves and its sand proportion (carbonate >150 µm) it is to be clarified, whether the late Quaternary water masses (both temporally and spatially) influenced fluctuations in the depth of the lysocline and thus variations in carbonate dissolution. These investigations will be performed on selected sediment cores from water depths ranging between 1.000 and 4.000 m. The carbonate curves produced from these depth ranges on the Campbell Plateau and on the South Tasman Rise reflect the physicochemical characteristics of ancient deep water masses and document the depth fluctuations of the lysocline. Together with analyses of stable isotopes in foraminiferal tests the influence of the open ocean on carbonate dissolution will be reconstructed. An important prerequisite for the reconstruction of the palaeodepth of the lysocline is the knowledge of its current depth. The [CO_3^{2-}]concentrations in one or two water profiles shall be determined on board (via the determination of the alkalinity and CO_2). The intersection of the [CO_3^{2-}] profile with the depth-dependent $CaCO_3$ saturation curve determines the depth of the lysocline.

Transfer functions

A well established tool of palaeoceanographic reconstructions is the use of transfer functions with planktic microorganisms. The surface circulation pattern of the investigation area ,as part of the circumantarctic ocean, is characterised by particularly strong and large polar frontal systems, which accompany with distinct temperature gradients. The variations in their movements and extent during the last 70,000 years will be reconstructed, for the first time, in the context of the TASQWA project. This will be based on planktic foraminiferal species and assemblages and transfer equations in different time scales (Thiede *et al.* 1997; Weaver *et al.* 1998). Results from the polar ice cores taken in both hemispheres during the recent years raised new questions, in which the distribution of water temperatures and the associated - inter-hemispherical - warming and humidity supply might become a key role.

Late Quaternary palaeoceanography of the SW Pacific Ocean

The deep-sea sedimentary record can be a sensitive monitor of past and present global conditions, with past conditions that are similar in kind or process useful in determining future oceanographic conditions. The New Zealand environment occupies a unique oceanic position, far from continental influences, in which to assess past global oceanic circulation patterns. Overall there is little core or oceanic control data for the Southern Hemisphere compared to the Northern Hemisphere, certainly for the New Zealand sector of the Southern Ocean.

As with other oceans the Southern Ocean has been subject to major equatorward shifts of ocean fronts during glacial periods (Hays *et al.* 1976, Prell *et al.* 1979). However, in the New Zealand region frontal migrations appear not to be simple north-south migrations but rather significantly controlled by the topography and current structure in the region (see section 8.3.1). Campbell Plateau was bathed by cooler than present day waters during the Last Glacial (Weaver *et al.* 1998), with the possibility of a warmer tongue of water over the central plateau as exists in the present day (Weaver *et al.* 1997). This cooling is most likely a response to upwelling, wind and current driven transport of cooler waters (Gordon 1972; Bryden & Heath 1985; Moore *et al.* 1980) rather than a wholesale shift of the SAF which remains trapped by the plateau edge. Likewise, iceberg drift over Campbell Plateau to Chatham Rise is suggested to occur (Cullen 1962). A compression of waters south of the Subantarctic Front (SAF), i.e. the Polar Frontal Zone (Patterson & Whitworth 1990) occurs as a consequence of northwards migration of the Antarctic Polar Front (APF) as suggested by Nelson *et al.* (1993) in this region and Hays *et al.* (1976) and Howard & Prell (1992) for the Indian and Atlantic Oceans.

Despite northward movement of the southern surface waters, the glacial Subtropical Front (STF) has remained close to the crest of Chatham Rise (Fenner *et al.* 1992; Nelson *et al.* 1993). The STF is best developed during glacial summers with a temperature gradient exceeding 3° C per 1° latitude at the rise crest. However, winter distribution of isotherms suggest a slight northward displacement (Weaver *et al.* 1998) although this is in range with seasonal migrations of the modern STF (Chiswell 1994). As with the modern STF, the glacial STF is most likely constrained to its location over Chatham Rise by eastwards flowing currents along the northern and southern flanks of Chatham Rise (Weaver *et al.* 1998; Carter *et al.* 1998) similar to the mechanism invoked by Gardner and Hays (1976) for the Intertropical Convergence Zone in the equatorial Atlantic.

The supply of deep water to the Pacific Ocean is dominated by the Deep Western Boundary Current (DWBC) that flows northwards out of the Southern Ocean along the east side of the Campbell Plateau. The DWBC enters the south-west Pacific, coupled with the Antarctic Circumpolar Current (ACC), through gaps in the Macquarie Ridge complex and is considered to have been active since the mid-Oligocene (Carter & McCave 1994). These currents decouple near Bounty Trough with the ACC turning eastwards while the DWBC continues to flow north. Supply of cold water to the deep Pacific from the main generating areas in the Weddell and Ross Seas is modulated by the ACC, which mixes these waters with North Atlantic Deep Water (NADW) to form Circumpolar Deep Water (CPDW) (Gordon 1975), the main watermass of DWBC flow. In glacial times intensification of the ACC may well have enhanced flow of the DWBC, however the vigour of this deep current may also have been reduced as a consequence of diminished AABW production (Pudsey *et al.* 1988; Kumar *et al.* 1995), a component of the DWBC.

Glacial surface, intermediate and deepwater masses of the south-west Pacific sector of the Southern Ocean have been characterised by Neil (1997). Subtropical Surface Water (STSW) and Subantarctic Surface Water (SASW) which lie north and south of the STF respectively were cooler (by up to 6° C) and locally better ventilated due to wind enhanced downwelling associated with the STF as well as enhanced formation of well ventilated Subantarctic Mode Water over Campbell Plateau. Glacial Antarctic Intermediate Water (AAIW) was also a cooler (by ~1.5° C) and younger or better ventilated water mass than its present day counterpart. This holds especially true for southern-sourced AAIW which enters the New Zealand sector of the Southern Ocean directly from its formation area at the Antarctic Polar Front, as opposed to northern-sourced AAIW which enters the Pacific Ocean up the west coast of South America before looping westwards and back into the New Zealand region via the Tasman Sea. The enhanced ventilation of glacial AAIW is due to both changes at source i.e. increase of Antarctic Surface Water relative to North Indian Intermediate Water as suggested by Lynch-Stieglitz *et al.* (1995) and enhanced formation of SAMW coupled with deep winter convection and wind-induced mixing. North Atlantic Deep Water (NADW) is a primary component of the modern deep water mass of this region, CPDW. Today two distinct zones occur within CPDW - upper CPDW which displays a distinct oxygen minimum, and lower CPDW which contains a salinity maximum. Reduction in the production of NADW or changes in its flux to the glacial ocean (Oppo & Fairbanks 1987; Charles & Fairbanks 1992) result in a glacial CPDW that is cooler (up to 4° C) and less ventilated than its modern day counterpart. Decrease in production of Antarctic Bottom Waters may also result in a decrease in the vigour of deep flow and a concomitant increase in the thickness of glacial AAIW.

8.1.4 Sedimentology and carbonate mineralogy

Sedimentology

Introduction

The classification schemes used in describing the cores follows Berger (1974). All cores were described using the ODP visual core description forms. The were digitised using the programme AppleCore. Sediment classifications are based on visual interpretations with a handlens and might be slightly alter after XRD-, carbonate-content, and smear-slide analysis.

Challenger Plateau

SO136-003GC, SO136-011GC, and SO136-013BX

The cores show a rather monotonous lithology. The sediment consist of silty foraminiferal ooze to foraminifers bearing clayey silt. The major grain-size of the sediment lies within the fine silt fraction. Some medium sand sized grains are present. These grains are planktic foraminifers and black angular clasts. Whether these clasts are charcoal or volcanic glass could not be determined. The major variations that actually are found in the cores are the type of bioturbation and the sediment colour. Two types of bioturbation are present: (1) large burrows filled with sediment with a distinct other colour and (2) small *Planolites* burrows with a clear layer parallel to bedding orientation, a preferential horizontal orientation. Within the latter clear burrowing directions can be seen. The maximum vertical extent of the burrows is 20 cm. The sediment colour varies between light greenish grey (10GY 7/1) to greenish grey (5GY 5/1; 5GY 6/1; 10GY 6/1) and very dark grey (N3/). Black pyrite streaks frequently occur. In the lower part of shallowest core SO136-003GC (6.70 m; W.D. 958 m) a softground is present. It is crosscut by long burrows. Some charcoal pieces as well as echinoderm spines were found. All in all the cores are characterised by subtle lithologic variations with some distinct burrowing features and colour variations. The length of the cores recovered was 7.70 m (SO136-003GC) and 8.92 m (SO136-011GC).

East Campbell Plateau

SO136-019BX, SO136-025BX, SO136-031BX, SO136-037BX, SO136-043BX, SO136-050BX, and SO136-054BX, SO136-020GC, SO136-032GC, SO136-033GC, SO136-038GC, SO136-044GC, SO136-051GC, and SO136-055GC

All sediments recovered were marl oozes with varying percentages of very fine to medium foraminiferal sand. Most of the sediments are intensively bioturbated. In the shallowest cores (SO136-051GC at 760 m W.D. and SO136-055GC at 563 m W.D.) very well preserved burrowed firmgrounds were found. Brachiopods probably were the main biota burrowing these firmgrounds. The sediments of the other deeper cores are heavily bioturbated and merely only show vague boundaries that are related to bioturbation intensities and colour changes. Colours vary between white (5Y 8/1) and pale yellow (5Y 7/3) to pale olive (5Y 6/3). Recovery varies between 0.00 (deepest station) and 5.45 m (shallowest station).

The sediments found in the box cores are foraminiferal oozes with relative high quartz contents (019BX), and foraminiferal sands, well sorted silt to coarse sands. Blackened foraminifers, angular fine sand clasts (volcanic glass?). Dropstones with manganese crusts were in found box core SO136-025BX in the upper layer. Colour varies from light olive brown (2.5Y 6/2) to light brownish grey 2.5Y 5/4) in the deeper water box cores (SO136-019BX and SO136-025 BX) from white (N8/) to light greenish grey (5GY 7/1) in the shallower box cores (SO136-031BX; SO136-043BX; SO136-050BX). Bioturbation intensities vary throughout the sediments of the box cores.
Recovery varies between 19 and 38 cm.

South Campbell Plateau

SO136-060BX, SO136-068BX, SO136-076BX, SO136-082BX, SO136-088BX, SO136-093BX, and SO136-098BX, SO136-061GC, SO136-069GC, SO136-070GC. SO136-077GC, SO136-083GC and SO136-099GC

The total amount of sediments recovered at the South Campbell Plateau was rather limited. The box corer almost all recovered sediment, but only gravity core SO136-061GC (W.D. 602/610 m) was successful in bringing up sediments to the surface. The sediments in this 2.25 m long core are comprised of coarse silty foraminiferal ooze to fine sandy foraminiferal ooze and are heavily bioturbated. Colours vary between various shades of white (N8/; 5Y 8/1) and grey (5Y 7/5; N7/; N6/) to light greenish grey (10Y 8/1) and greenish grey (10Y 6/1). Black streaks do occur. The main coarse components are planktic foraminifers and some black angular grains (glauconite or pyrite?). Bioturbated firmgrounds occur at various levels within the core.

The sediments present in the box cores SO136-060BX, SO136-068BX, SO136-082BX, and SO136-098BX are composed of very well sorted foraminiferal sands with some glauconite and pyrite. The sediments are heavily bioturbated except for the upper 2-4 cm in which usually clear signs of recent current induced sediment transport could be observed (small-scale current ripples). The sediment thickness in the box cores varied between 18 and 33.5 cm.

Emerald Basin

SO136-101BX and SO136-100GC

In comparison to the previous sites the sort of sediments recovered in the Emerald Basin is completely different. Waterdepth and its relative isolated offland position are probably the major sedimentation modifiers in this respect. The sediments consist of siliceous oozes with a series of diatom intercalations in the upper part (1.20 m to 1.50 m) of the 6.26 m long core. The lower 3 metres of the core (3.42 m to 6.26 m) are composed of well burrowed hemipelagic clays. Some slight changes can be seen in burrowing intensification (mottling) that are associated with increased pyrite appearance. The sediment colours vary between various shades of grey (e.g. 2.5Y 6/1; 5Y 5/1) to brown (10YR 5/3) and dark reddish grey (5YR 4/2). Few foraminifers are present in the upper 3 metres, very fine sand fraction. In this part burrowing is virtually absent. The most remarkable feature are the white to grey diatom intervals that seem to be made up of papersheet thin algal mats.
Cores SO136-111GC and SO136-117GC both showed similar features. The latter being more intensively burrowed. The diatom horizons are not that clear, but the overall

dominance of siliceous fossils is striking. In Core SO136-111GC a remarkable feature appeared; thin mm-thick black somewhat more clay rich intervals. These intervals crossed burrows and thus must be formed by diagenesis within the sediment in a later stage after deposition and burrowing. This feature appeared more clearly in Core SO136-117GC at 9.00m. In the same core section at 9.56 m one of these laminae was burrowed once again. The black coloured laminae usually appear in twin pairs and are surrounded by grey coloured intervals on the up-core and down-core side. Colour varies between dark greyish brown (2.5Y4/2) for the laminae to light olive brown and light brownish grey (2.5Y5/3 to 2.5Y6/2) for the 20 to 35 cm thick burrowed intervals, and pale yellow (2.5Y7/3) to white (2.5Y8/1) for the burrows. The length of the cores recovered were 6.26 m, (SO136-100GC), 9.61 m (SO136-111GC), and 10.69 m (SO136-117GC) respectively.

All in all the cores in this basin are characterised by siliceous oozes to very siliceous clays with its relative richness in siliceous fauna (diatoms and radiolaria), and the almost total absence of calcareous input. Only a few forams were present. Intensive burrowing with various types of burrows characterise its appearance. In addition, the laminations of diagenetic origin which cross burrows, give the sediment a false contourite appearance.

Both box cores that were deployed successfully (SO136-110BX and SO136-116BX), showed foraminifers bearing diatom/radiolarian ooze similar in texture, colour and bioturbation structures as the sediments from the gravity core. The sediment thickness in the box cores varied between 33.5 and 36 cm.

South Tasman Rise

SO136-124GC, SO136-154GC, SO136-155GC, SO136-162GC, SO136-163GC, SO136-164GC, and SO136-166GC;
SO136-123BX, SO136-129BX, SO136-138BX, SO136-139BX, SO136-140BX, SO136-141BX, SO136-146BX, SO136-147BX, SO136-153BX, SO136-156BX, SO136-161BX, and SO136-165BX

The first core on the South Tasman Rise being SO136-124GC, recovered a series of Mn dominated siliceous clays. Only the top showed some calcareous input, but from 0.35 m down to the base of the core at 7.73 m, siliceous fossils (e.g. radiolarians) and clays prevailed. Mn-nodules were found at various levels within the core (0.00-0.08, 0.32-0.36, 3.62-3.69, 3.77-3.84, and 6.26-6.31 m). The overall grainsize decreases downcore from a medium sand to coarse silt. Mn-granules as well as radiolarians (up to medium sand size) were present throughout the entire core. Quartz was present in minor amounts. Colour varied between light grey (2.5Y7/1) and dark brown (10YR3/3). The Mn-nodules were black in colour (2.5Y5/1). Bioturbation varied from moderate to intensive. Between 6.84 and 7.03 m a level with pink coloured clays and parallel burrowed layers (*Zoophycus* type?) were found.

The second core analysed was SO136-155GC. Except for SO136-154GC and SO136-166GC which returned to deck empty, all other cores were only scanned and not opened due to time constraints. Core SO136-155GC consists of a series of foram-bearing marl ooze with an intercalation at 3.04-5.62 m of well sorted very fine- to medium-sand sized foraminiferal sand. The lower boundary of this fining upward interval is erosive. Below this interval, 5.62-7.56 m (EOC), a coarsening upward cycle is present which ranges from foraminiferal marl ooze to medium-sand sized foram-bearing sandy silt. Colour varied between light grey (2.5Y7/2) to pale yellow (2.5Y7/3) and white

(2.5Y8/1) for the oozes, and white (5Y871) to light grey (5Y7/1) for the foraminiferal sand. Within the oozes intervals with laminations or fine streaks with pale red (2.5YR7/2) to reddish grey (2.5YR6/1), and greenish (10GY7/1) colours were observed. These coloured laminations and streaks are probably of diagenetic origin. Angular silt-sized pyrite-, manganese-, and glauconite grains were found throughout the entire core. Bioturbation was poor to moderate. Recovery varies between 7.77 (124GC) and 9.78 m (164GC).

The sediments present in the box cores varied from manganese rich foraminiferal sand (SO136-123BX) to well sorted foraminiferal sand (SO136-138BX, SO136-140BX, SO136-141BX, SO136-147BX, SO136-153BX, SO136-153BX), and coarse silty foraminiferal ooze (SO136-161BX). Bioturbation intensities varied throughout the different lithologies from poor within the sands to heavily within the oozes. Colours varied between very pale brown (10YR82) and white (2.5Y8/1). Some current ripples were found in the foraminiferal sands. The sediment thickness in the box cores varied between 10.5 and 40 cm.

The objectives of the sedimentological subproject covered two aspects:

seeking out bottom current systems, which can be assigned to the "deep branch" of the Conveyor Belt model. Grain size analyses on long cores will give information on long- and short-term trends in palaeo-current speeds and palaeo-current paths. Correlation of the results with palaeo-climatic proxies will reveal links between climatic parameters and bottom currents in the deep-sea, as well as indicating the possible link between the activity of bottom currents and the deep water production rate in the North Atlantic and in the Antarctic. A sediment accumulation on the leeward side of the Tasman Rise will be checked with

- methods of the carbonate mineralogy on the cold water carbonate banks;
- the aragonitic and pelagic signals will be examined (variations of the pteropod input; shallow water input of bryozoans, serpulids, scaphopods, cirripedia; and cold water carbonates).
- the proportion of high magnesium carbonate by red algae, foraminifera, sponges, bryozoans, echinoids will be examined and compared to the platform systems from geological history modern/fossil; e.g. the Carboniferous in Spain and the Mesozoic in southern Spain.

Carbonate content

The measurement of carbonate content on a moving ship bears obviously some difficulties. Nevertheless, the results obtained from the measurements are reliable and support the information retrieved by the core logging and the photospectrometry.

Material and methods

Samples were obtained from all box and gravity corers. In total more than 400 samples were investigated for their calcium carbonate content. The GC were sampled in order to show changes of $CaCO_3$ during glacial – interglacial transitions in regularly distance, with a maximum of 35 samples per core. The box corers were sampled in 5 or 10 cm distance.

Samples were analysed using a so-called "carbonate bomb". The instrument was standardised by pure $CaCO_3$ – 0.75 g of sediment has been taken from all samples. The carbonate bomb measures the CO_2 pressure released by the reaction of HCl with calcium carbonate. Using always the same amount of sediment (as standardised before) the relative carbonate content is directly shown by the pressure gauge of the instrument.

Analytical errors and problems

Because of the heavy swell and permanent motion weighing on board is quite difficult, therefore a slight difference between the results on board and "onshore" can be expected. Using a carbonate bomb it is not possible to measure calcium carbonate concentration lower than 5 %; all given percentages under 5 % were estimated by a "minimum movement" of the needle.

X-Ray diffraction analyses

The XRD procedure followed is a standard procedure described in various literature, including Milliman (1974). The samples chosen for analysis were the surface samples within each of the gravity cores and were taken to provide an insight into variation in the mineralogical content of the surface sediment in a spatial context. In addition, in each major area, one core was chosen to provide information on mineralogical changes through depth\time. In this case, usually one sample per metre of core retrieved was utilised, unless the core was short or there was something of interest, then the frequency was intensified. In some situations additional samples were taken from the box cores, especially where there was no Gravity Core recovery. The samples were chosen so that the resultant data set could be cross-correlated with the $CaCO_3$ data (see Chapter 8.1.4). A list of the samples used with their position and depth can be found in Appendix A100.

Methods

The analysis was carried out on approximately 0.5 g of bulk sediment. Each sample was oven dried at 40° C, before being ground, for exactly 4 minutes, in an agate mortar. This provides a more homogenised sediment and thus reduce errors that might seriously affect the quality of the results. The grinding time has been documented as that required to provide an optimal peak intensity for XRD analysis (Milliman 1974). The individual samples were then compressed into small tablets of a standard size and thickness with a smooth, flat surface before being subjected to X-rays.

The samples were analysed using a Philips automatic PW 1840 power diffractometer at 40 kV and 40 mA, through a scan from 2° to 70° 2τ, at a low scan speed of 0.010° per second for optimal resolution. The peak intensities were measured for the carbonate phase (aragonite, high- and low-magnesian calcite and dolomite). In addition an attempt was made to record the presence of silicilastic minerals, including quartz, feldspars (orthoclase and albite), micas (muscovite and biotite), clay minerals (illite and smectite/kaolinite), halite, and heavy minerals e.g. hornblende. However it must be noted that no preparations or standards were used before or during the analysis so these results are by no means final.

The programme MacDiff v. 3.1.5 (Petschik 1996) was then utilised to determine the relative amounts of these minerals, by measurement of the peak intensity which is directly related to the peak height and area (Milliman 1974). Most minerals are only commented on in terms of whether they are present or not. The percentages of the carbonate minerals could be calculated though calibrations made using an "in-house" calibration curve formed from a series of measurements carried out on two component standards at GEOMAR, Kiel, Germany. These consisted of a laboratory produced, synthetic calcite and a pure aragonite from a Red Sea Coral. The percentage of dolomite could then be calculated using the linear correlations by Milliman (1974). However, as only LMC was found in the cores processed, this was not necessary and the percentage representation within the sediment can be found by looking at the total $CaCO_3$ concentrations.

Results

Challenger Plateau

The results of the XRD analysis show there to be relative uniformity, in terms of mineral content, within the sediments specially along the Challenger Plateau. In terms of the carbonate mineralogy, only low-magnesian calcite (LMC) was present with only possible traces of high magnesian calcite and dolomite in some samples. However the intensities for the latter two minerals were within the noise range so their presence is not

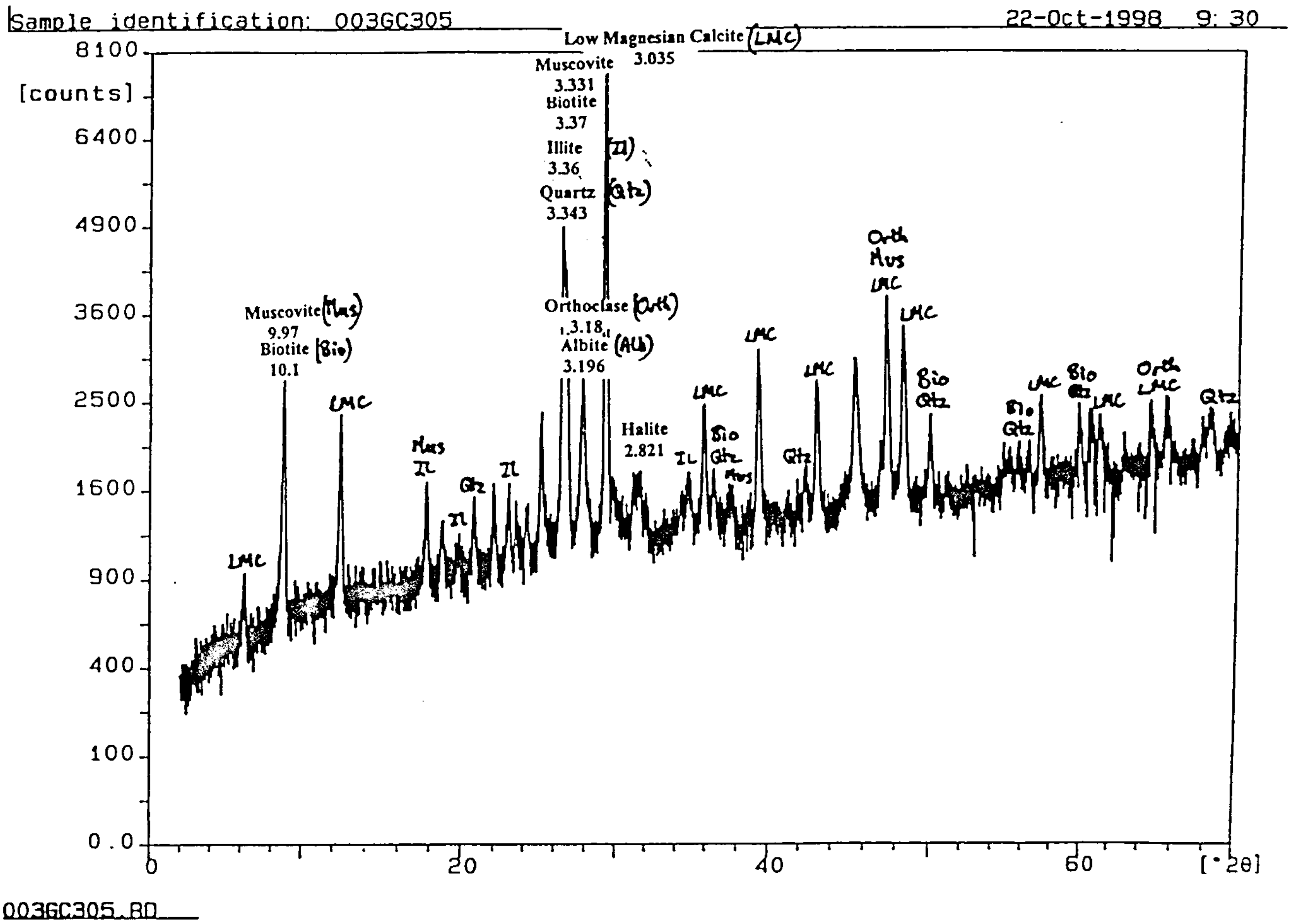

Fig. 12: Results of the XRD analysis on downcore sample 305 cm of Core SO136-003GC including all identified peaks.

certain. The mineral showing the second strongest intensity was quartz, followed by the micas muscovite and to a lesser extent biotite. The feldspars, orthoclase and albite could also be present, as well as some traces of the clay mineral illite. The LMC forms the pelagic input from planktic foraminifers, while the presence of the silicilastic minerals such as quartz and the micas probably originate from the West New Zealand Fjordland biotite schist. This sediment is described as a silty foraminiferal ooze to foraminifers bearing clayey slit with medium sand size planktic foraminifers and black angular volcanic glass (see sedimentology section). At Station SO136-003GC, the intensity of the carbonate minerals increases downcore, especially below 300 cm, the reverse pattern is seen for quartz, the clay minerals, Feldspars and Micas, which decrease in intensity with depth downcore (see Fig. 12 and Appendix A88).

East Campbell Plateau

In general the sediment in this region consists of the carbonate mineral: LMC. On the few occasions that additional minerals made an appearance it was general the micas, and in particular muscovite, that was in highest intensities. Quartz also makes a sporadic appearance in very minor amounts, as do the feldspars. These minerals probably derived from the East New Zealand Central Otago chlorite schist (rich in muscovite with minimal amounts of biotite). However, these minerals appeared at the more proximally placed sites (denoted by the box cores at Stations SO136-025BX and SO136-031BX) with decreasing presence with distance from the source (denoted by the gravity cores at Stations SO136-038GC, SO136-044GC, SO136-051GC and SO136-055GC). This general lack of silicilastic input suggests that the area surveyed on the East Campbell Plateau was to distally situated and thus starved of these minerals. This could also be affected by the regional topography which would facilitate sediment bypassing of any siliciclastic sediment reaching these sites. In addition the oceanic currents and water movement would play a role. The sediment is described as foraminiferal oozes with relatively high quartz content and foraminiferal sands for the box cores and a marl ooze with varying percentages of very fine to medium foraminiferal sands for the gravity cores (see sedimentology section). In Core SO136-038GC, the intensity of LMC stays consistently high throughout the core, with the exception of an interval at 50 cm. While quartz only appears with very low intensities at certain intervals in the lower core section, all other minerals are completely absent through the core (see Appendix A91).

South Campbell Plateau

In this area of the Campbell Plateau, a similar trend to that seen within the mineralogy of the East Campbell Plateau exists, whereby the carbonate mineral LMC shows the highest intensities. However, there is an indication that other siliclastic minerals could also be present, depicted by their intensities. The strongest intensities are shown by the feldspar minerals orthoclase and albite, with lower intensities for the micas (biotite and muscovite). Hornblende and titinite may also be present. These minerals could derive from the West New Zealand Fjordland biotite schist (rich in muscovite and to a lesser extent biotite) and/or the volcanic sediments of the Puysegur Trench brought south through the channel of the Solander Trough. The sediment is described as a coarse, silty foraminiferal ooze to fine, sandy foraminiferal ooze with varying amounts of black angular grains (glauconite and/or pyrite) (see sedimentology section). At Station SO136-061GC, the intensity of LMC is consistently high throughout the core, however, variations are seen in the intensities of the other minerals. Quartz decreases in intensity down to 125 cm and then increases again with depth. While the feldspars show a similar downcore pattern, there is an increase in their intensities within the upper 85 cm. The micas only appear in the upper 125 cm of the core (see Appendix A94).

Emerald Basin

Although the carbonate mineral LMC shows the highest intensities, they are much reduced when compared to the previous areas. This is due to an increase of the intensities of the siliciclastic minerals as especially quartz. In addition the feldspars, orthoclase and albite also show very high intensities and to a lesser extent the micas (muscovite and biotite). The intensity of the clay mineral illite is the highest seen for any of the areas surveyed. In Core SO136-111GC the intensities of all the minerals show fluctuations downcore. LMC shows its highest intensities in the upper 550 cm while quartz shows a negative correlation with lowest intensities above 550 cm. In terms of the general increases and decreases in mineral intensities in the upper core section (above 550 cm) the micas and clay mineral illite show a positive correlation to quartz whereas the feldspars give a negative correlation. Below 550 cm all the siliclastic minerals positively correlate to one another and show a negative correlation to LMC. The sediment in this area is described as siliceous ooze to very siliceous clays, relatively rich in siliceous fauna (diatoms and radiolarians) and almost absent of calcareous input with only a few foraminifers (see sedimentology section). Thus the major contributor to mineralogy of the sediment in the Emerald Basin is again the West New Zealand Fjordland biotite schist probably transported through turbidity currents. Possibly, to a minor extent, the volcanic regions to the west such as the Macquarie Ridge and the Hjort Trench, the Solander Trough and Puysegur Trench to the north could also have some influence. This siliclastic input therefore dilutes the pelagic signal (the LMC). The general fluctuations in the mineral intensities with depth downcore probably signify periods of higher and lower erosion and transport from the West New Zealand Fjordland region (see Appendix A97).

South Tasman Rise

Only three sites were looked at in this region, where one core from the IMAGES III - iplis expedition 1997 was already examined by Suhonen (1998). The first, Station SO136-124 was the most southerly and easterly of the South Tasman Rise stations and is the only one to show siliclastic input, e.g. quartz, illite, the micas (muscovite and biotite) and the feldspars (orthoclase and albite) These probably derive from the South Tasman Rise and possibly the Australian continent. The sediments at the other two stations analysed show only carbonate mineralogy, specifically LMC. The intensities for quartz indicate only trace amounts to be present. Therefore this region is dominated by pelagic sedimentation e.g. a foraminiferal ooze.

8.1.5. Surface sediment composition

Surface sediments were requested for sampling benthic fauna (planktic and benthic foraminifera, ostracodes, nematodes, invertebrates), on board chemical measurements (XRD, carbonate content), biochemical measurements, surface sediment profile description and whole column of sediment sampling for respective core tops, isotope investigations, and whole column sediment sampling for archives in New Zealand, Australia and Germany. Descriptions of the benthic faunal associations are to be found at Chapter 8.2.2. Standard sampling procedures using syringes and plastic bags have been applied, and standard descriptions methods of box corer sediment columns also.

Challenger Plateau

The surface sediment at 600 m water depth was found to be light brownish, fine sandy foraminiferal ooze with muscovite and quartz grains, and common benthic fauna. With increasing depth to 1500 m foraminiferal oozes get more silty, and in the deepest station sediments consist of silty clay. Benthic standing stock decreased.

Campbell Plateau

At the eastern locations, sandy to silty foraminiferal oozes with manganese grains are dominating up to 3400 m water depth. Grain sizes increase with decreasing water depth, and winnowing is supported by extremely well sorted, whitish, coarse foraminiferal sands up to 1500 m water depth. Fine sandy foraminiferal ooze with minor clay contents was found from 1300-1000 m, medium sandy towards sandy foraminiferal ooze was found at 1000 m to 550 m water depth.

At the southern transect, down to 1700 m sediment composition was quite similar to the eastern transect, with medium to coarse white foraminiferal sands. Terrigenous matter, however, is enriched in comparison to the eastern transect. Below 4000 m, manganese grains started to be common. At 5000 m water depth, silica dominated, mainly due to diatoms and radiolarians, in a siliceous ooze with still well preserved planktic and benthic foraminifers in the surface sediments.

Emerald Basin

Fine silty, foraminifers bearing siliceous oozes are found in the Emerald Basin, with a surprising rich benthic fauna. Diatom frustules are extremely abundant, carbonates are found only in the uppermost sediment layer, and the consistency of the sediment is a semiliquid matter, called "marshmallow sediment" by our New Zealand colleagues. Neither epibenthic nor infaunal macrofauna was found.

South Tasman Rise

In the deeper stations of the southern rise, white to light grey, well sorted foraminiferal sands are dominating, somewhat resembling the sediments at the Campbell Plateau. However, the number of benthic biota found on the sediment surface, in first small tube building polychaetes, was distinctively higher. Towards the shallower and northernmost stations, the clay content increased, as did the number of micro- and macrofaunal species. Slight greenish colouring within burrows at 5-10 cm sediment depth are considered to result from local suboxic environments due to higher organic degradation within the bioturbated zone.

8.2 Planktic and benthic biota

8.2.1 Phyto- and zooplankton

Plankton collections

Plankton samples have been collected with a variety of means (see remarks in stationlist in the Appendix A4 - A24), such as continuous pumping, plankton tows and bucket samples, subsamples of the CTD. They have been analysed and preserved on board, but many of the intended studies can only be carried out at the home laboratories of the researchers involved. To our knowledge, so far there has been no systematic attempt at collecting calcareous and siliceous plankton from the southern portion of the Tasman Sea. Our aim is to remedy this gap. In addition, ecological characteristics of the faunal and floral assemblages to be collected at the surface in depth transects will provide the necessary information for the interpretation of fossil remains of planktic organisms to be recovered in the cores taken during the cruise. The plankton tows were taken in two steps from 100 m-0 m and 200 m-0 m with a net of 46 µm and the bottom basket of 41 µm. 1l of each plankton sample was filtered, washed with water and stabilised with Methanol. In some tows of the East and South Campbell Plateau salpes of different sizes were caught. The samples are provided to P. De Deckker, ANU, Canberra, Australia.

Nannoplankton

Very little is known about the modern calcareous nannoplankton distribution in the Tasman Sea. This group of organisms plays a very important role in the 'indirect' uptake of CO_2 from the ocean via their skeletons that are made of calcium carbonate. Most of these organisms live near the surface of the oceans as they have to receive light in order to photosynthesis. These are best described as calcareous algae. Most taxa live in the mixed layer of the ocean that is often in equilibrium with the atmosphere with respect to the exchange of atmospheric and oceanic gasses.

Upon death, the calcareous remains of nannoplankton also sink to the sea floor and thus have the potential to 'store' some 'transformed carbon dioxide' via the calcitic lattice of the nannoplankton. Thus, a better knowledge of the modern-day distribution of the nannoplankton will help interpret the fossil remains of these minute algae. Eventually, through the analysis of fossil nannoplankton in the cores collected during the cruise, we will be able to determine past oceanic changes at the surface of the Tasman Sea. Surface water samples were taken by a bucket at each station. For nannoplankton analyses 5 l seawater were filtered (0.45 µm cellulose nitrate-filter) and stabilised with methanol. The samples were provided to P. De Deckker, ANU, Canberra, Australia.

Stable isotope samples for analysing $^{18}O/^{13}C$ and trace elements

At present, there are no data available with the isotopic composition of waters from the Tasman Sea. None of the international transects [e.g.GEOSECS] which aimed at taking water samples world-wide went to the Tasman Sea. Therefore, our sampling is aimed at remedying this discrepancy. The overall objective at collecting waters for their analysis of the stable isotopes of oxygen and carbon is to determine the characteristic signals of both surface and other waters masses in the region. Once we gained those data, it will be easier to define the characteristics of individual water masses, and also interpret the relevant isotopic signals to be obtained in the calcitic tests of modern and fossil planktic and benthic foraminifers to be also collected during the cruise. One outcome of this investigation is to determine whether various eddies that are offshoots of the East Australia Current can be traced back to their origin, simply by sampling their isotopic signal. The same could possibly be done for some trace elements, such as magnesium, calcium strontium and barium which will be sampled at the same time as the stable isotopes.

The water samples, which are provided for stabile isotope analyses, were taken from the CTD and the surface sample with the bucket. The water was filled in "Macathy" vials (30 ml) and was stabilised with 0.6 µl Mercury-(II)-chloride-solution and properly closed.

The water samples for trace elements were taken from the CTD, filled in cleaned 30 ml PP-bottles. For stabilizing the water samples 30 µl conc. HCl (p.a.) were added to each sample, taped with parafilm and packed in plastic bags.

The PP-bottles were washed with Mucasol solution (1-2%), cleaned 3 times with distilled water, filled with suprapure water and added 30 µl conc. HCl. After 1 week by 60° C the bottles were washed 3 times with suprapure water, filled with suprapure water and added 30 µl conc. HNO_3. All bottles closed properly, taped with parafilm and packed in plastic bags. The stable isotope samples are provided to P. De Deckker, ANU, Canberra, Australia. The trace element analyses will be done at GEOMAR, Kiel, Germany.

Coccolithophorids

The objectives of the coccolithophorid study within the TASQWA project are twofold; to collect, isolate and maintain in culture living coccolithophorids to add to the CODENET culture collection; to describe the composition and abundance of planktic coccolithophorid assemblages within the study area.

CODENET, the Coccolithophorid Evolutionary Biodiversity and Ecology Project, is a network of European laboratories conducting an integrated research programme into aspects of the distribution, morphology, ecology, genetics and biochemistry of living coccolithophorids, together with palaeoceanographic studies on the fossil record (see website *http://www.nhm.ac.uk/hosted_sites/ina/CODENET*). Many of these research tasks involve culture experimentation under controlled laboratory conditions; to this end 6 keystone taxa have been selected covering coccolithophorid diversity, and a primary objective, undertaken by the research teams at the University of Caen in France and the ETH Zurich in Switzerland, is to isolate unialgal cultures of these coccolithophorids. In order to study intra-, as well as interspecific variabilities, clones of each species from as many geographical locations as possible are required. The culture collection, details of which are regularly updated on the website, is maintained in duplicate in Caen and in Zurich.

Research on living calcareous nannoplankton in the Tasman Sea and Southern Ocean is limited (Hasle 1960, 1969; Norris 1961; Nishida 1979, 1986; Hallegraef 1984, Findlay 1998). As in other regions, the coccolithophorid assemblages in the Tasman Sea/Southern Ocean are distributed in biogeographic zones associated with changes in oceanic properties, including temperature, salinity, light and nutrient levels. Three coccolithophorid assemblages (subtropical, subantarctic and antarctic) were identified between 44° S and 64° S South of Australia (Nishida 1986). In the same region, Findlay

(1998) defined 5 assemblages associated with distinct biogeographic zones (tropical/subtropical, subtropical/transitional, transitional, subantarctic, antarctic). Published studies on coccolithophorid assemblages in this region have, to date, all been based on surveys conducted during the austral summer, and data for the waters south of New Zealand is scarce. The TASQWA cruise provides the opportunity to study samples collected in both the New Zealand and Australian sectors of the Tasman Sea/Southern Ocean, and the data will provide an interesting seasonal comparison with previous studies.

Methods

Live samples are collected with a plankton net (5 µm mesh size). Deployed from the boat, the net is used to sample surface waters (0-10 m). To obtain living samples from deeper waters, the contents of several CTD rosette-sampler niskin bottles covering the depth range 10-200 m are concentrated through the same plankton net. Net samples are filtered through a 70 µm sieve to remove large zooplankton and debris. The sample is subsequently divided into 3 parts; the first is kept with no additions, to the second is added 0.1%v/v 0.4 M Germanium Dioxide (GeO_2), and to the last the same concentration of GeO_2 together with approximately 50%v/v K/10 medium. GeO_2 acts as a competitive inhibitor to the uptake of silica by diatoms, which are consequently selectively eliminated from the live sample. K/10 medium is made by filter-sterilising local seawater through 0.2 µm membrane filters, and subsequently adding prescribed concentrations of nutrients (nitrate, ammonium and phosphate), trace metals, a chelator and vitamins from sterile stock solutions. Samples are maintained at a water temperature as near to that at the time of sampling as possible, and are illuminated with a 14W cool white fluorescent light on a 15h light/9h dark cycle. The first culture isolations have been conducted on board ship, single coccolithophorid cells being separated using a very fine glass micro-pipette and placed in to 3 ml clear plastic Eppendorf tubes containing 1.5 ml of K/10 medium. Further isolations from mixed live samples will be conducted on return to the laboratory in France.

In order to study coccolithophorid abundance and species assemblages, the contents of 1 litre of seawater from each of 4 depths (10 m, 50 m, 100 m and 200 m) at selected CTD sampling stations is filtered onto 0.6 µm Isopore membrane filters, air-dried, and stored for subsequent examination under the Scanning Electron Microscope. The location of stations from which samples have been filtered is listed in Tab. 2.

Tab. 2: Station list of sampled sites for coccoliths studies.

Station number	Latitude S	Longitude E
1	42°17.70	169°50.70
2	43°26.13	167°51.74
3	50°51.17	176°53.16
6	50°13.89	175°18.63
7	50°07.99	174°41.61
9	50°10.00	173°22.03
11	54°05.03	168°30.00
14	55°30.00	165°52.05
18	56°28.95	162°73.60
22	52°48.80	150°35.56
29	48°30.01	149°06.72

Preliminary results

Several coccolithophorid species have been tentatively identified from light microscope observations:

Emiliania huxleyi
Calcidiscus leptoporus
Gephyrocapsa spp.
Syracosphaera spp.
Umbellosphaera spp.
Various holococcolithophorid spp.

Species diversity, as suggested by previous studies, declines southwards, with only *Emiliania huxleyi* and *Calcidiscus leptoporus* observed in the more southerly samples. *C. leptoporus* was seemingly dominant at many locations, the very small *E. huxleyi* cells perhaps not being retained by the 5µm net.
After SEM examination, coccolithophorid distribution will be related to physical oceanographic conditions measured by the CTD probe, hopefully providing additional insights into the ecology of these microalgae.

Organic walled dinoflagellate cysts

To date there is very little known about the dinoflagellate associations in the Southern Hemisphere. Recent investigations focus more on the problems with shellfish poisoning due to the transport of dinoflagellate cysts in ship's ballast water (e.g. Hallegraef & Bolch 1992, Hallegraef *et al.* 1991). Only a few studies report on recent marine dinoflagellates and related cysts (Bint 1988, McMinn 1991, 1992, McMinn & Sun 1994, McMinn & Wells 1997). For a better understanding of global distribution patterns of recent dinoflagellate cysts and their ecology, it is important to focus more on the associations in the Southern Hemisphere.

SO136-cruise has been sailing the Southern Ocean and the Tasman Sea and sampled transects of major interest to document the distribution of dinoflagellate cysts along the shelf edge and the continental slope. Additionally, sampling selected gravity corer profiles, it might be possible to record the shifts of the ocean fronts using dinoflagellate cysts as a tool to reconstruct the palaeoceanography during glacial - interglacial transitions.

Materials and methods

Samples were collected from all box corers (depth 1-2 cm) to get a first idea of the organic microfossil content. Unfavourable conditions on board - e.g. heavy swell - necessitated a modified preparation technique, which allows only a qualitative analysis. The samples were dried and treated with 10% HCl (no HF was added to avoid any dangerous circumstances). The remains were filtered onto a 20 µm sieve. Permanent microscope slides have been made using "Canada balsam" as a mounting medium.

Water samples (5 litres), collected by the CTD rosette sampler, were taken from depths of 10 m, 50 m, 200 m, 500 m, 750 m, 1000 m and from the maximum depth, which varies throughout the stations. The water was filtered with a waterstream-pump onto 8 µm membrane filters for later SEM investigation. Additionally, plankton samples were taken at irregular intervals during the cruise transits from the seawater-pump, which is installed 4 m below sea level. This material is preserved in formalin and stored in 25 m vials.

The gravity cores have not yet been sampled; after studying the carbonate content and photospectrometry pattern, it will be possible to sample more efficiently. These samples will, therefore, be taken in the near future.

Microfossil content, organic residue

Compared with other marine Quaternary locations, the dinoflagellate cyst content fro the sites during the TASQWA cruise are low in both abundance and diversity according to the modified preparation method. The amount of dinoflagellate cysts is diluted due to the high amount of siliceous microfossils. Nevertheless, individuals of *Impagidinium* sp. and *Brigantedinium* sp. have been found in both samples (SO136-004MUC, SO136-013BX) from the Challenger Plateau. Pollen grains, foraminiferal linings, copepod eggs and calpionellids have also been recorded and are part of the organic residue.

In water samples taken with the CTD on the Campbell Plateau at depths between 50 and 800 m (SO136-048CTD, 754 m; SO136-052CTD, 561 m) organic walled dinoflagellates of the genus *Ceratium* sp. were found. As predicted, the samples of the Emerald Basin lack of dinoflagellate species because of its deep-sea location. Samples from the South Tasman Rise have not been examined on board.

Objectives

The main objectives are dealing with the investigation of the amount of primary production contributed by dinoflagellate cysts in this oceanic area. The study of the dependence of dinoflagellate cysts on different physical-chemical parameters of the water by analysing surface samples will be the first step to detect the influence of different oceanic fronts. These results will be transferred by mathematical methods (transfer functions) to selected core material to see the variations inside the associations due to the variability of palaeo-climatic and palaeoceanographic proxies. Another point of major interest is to perceive differences in preservation evoked by various oceanographic parameters. Only a few studies report on oxygenation of organic walled dinoflagellate cysts in surface sediments, especially for cysts of the genus *Brigantedinium* (Jurkschat 1998, Zonneveld *et al.* 1997). The flux of organic dinoflagellates and related cysts through the water column may also be a part of this study to get an idea about the changes in the composition of dinoflagellate associations from surface water to the seafloor. Nevertheless, taxonomic questions should be solved

Diatoms and phytoliths

The main research interest is elucidating the Late Quaternary history of Southern Ocean deep- and surface-water circulation and chemistry. This project completes adequately the North-South transect along the Chatham Rise, started within ~~this~~- IMAGES III cruise in 1997. Objectives embodied within the project included a documentation of sedimentological and micropalaeontological parameters from surface sediments with the emphasis to study modern sediment depositional processes and distribution of siliceous microfossils as a baseline to the reconstruction of past environment and oceanography. Furthermore, the investigation should lead to a reconstruction of past sea surface temperature from micropalaeontological transfer function (diatoms, planktic foraminifers) and biomarkers (alkenones). A comparison of broad palaeoenvironmental and palaeoclimatic changes in the study area over the past 300,000 years is also expected from the results of that cruise.

Objectives

It is a major aim to improve the understanding of the living conditions of Quaternary diatoms by correlation with physicochemical characteristics of the water masses and by understanding their spatial distribution within a regional context. Modification of the diatom assemblages in connection with the palaeo-climatic and palaeoceanographic variability will be assessed with relation to variability of the oceanic fronts in relation to Quaternary climatic fluctuations.

Furthermore, determination of the preservation potential of the different species of diatoms through comparison of water samples obtained from the CTD with species recovered in the surface and subsurface sediments.

Relative and absolute diatom abundances will be used to quantify estimates of sea surface temperatures, salinities and seasonal sea-ice cover by means of transfer functions applied to modern databases. These quantitative data are valuable tools to determine the surface hydrology via migration of the frontal system.
Another point of interest is the documentation of the history of aeolian sedimentation in the seas east and south-east of Australia by the distribution of phytoliths in the sediment. The quantitative input of phytoliths permits the prediction of the climatic conditions of the surrounding land masses, e.g. an increasing aridity up to the potential development of large desert areas.

Diatom Geochemistry

As far as geochemical aspect is concerned, few studies have been undertaken in the Southern Ocean due to a lack of carbonates. Stable isotope measurement ($\delta^{15}N$ and $\delta^{13}C$) in diatoms is now a well calibrated technique (Sigman 1997). Investigations in the Indian sector of the Southern Ocean showed that a better utilisation of nitrates in surface waters of the Southern Ocean was a possible explanation for lower CO_2 atmospheric concentrations during the last ice age. These results are preliminary and it is of primary importance to multiply analyses in other sectors of the Southern Ocean. Hence, the coupled geochemical and micropalaeontological approach will provide a new insight for understanding the palaeoceanography of the Indo-Pacific gateway and its role on the glacial-interglacial atmospheric CO_2 concentration changes. Stable isotope measurements on diatoms microfossil-bound organic matter ($\delta^{15}N$ and $\delta^{13}C$) will be performed. Therefore, samples will be washed, dried and analysed for $\delta^{15}N$ and $\delta^{13}C$ by combustion in quartz tube of an elemental analyser on-line with a stable isotope mass spectrometer. These analyses will provide information on sea-surface chemistry (concentration and utilisation of nutrients, palaeoproductivity).

Radiolarians

The investigations to be carried out on polycystine radiolarians are suitable to solve the pending questions, since they provide the following possibilities:

- high-resolution biostratigraphy in the middle latitudes. When well preserved, Quaternary radiolarians prove to be more exact than planktic foraminifers in the determination of an age model.
- radiolarians react sensitively to modifications in the silicic acid content of sea water, therefore even small radiations become more evident.
- radiolarians are reliable indicators for periods of high-productivity. Their state of preservation can be related to volcanic activity in the sedimentation region.

The objectives will be achieved through the following investigations:

- complete micropalaeontological analysis of the sediment cores;
- establishment of the biostratigraphic zonation with special consideration given to the variability of morphological groups with high evolutionary rates;
- creation of a biodiversity index for the recognition of microradiations;
- quantitative analysis of Si-rich species for the recognition of silicic acid rich intervals;
- calibration of the data with planktic foraminifers and with siliceous benthic organisms;
- distribution of deep-, intermediate- and shallow- water species, as well as the classification and quantitative analysis of herbivorous, carnivorous and photoautotrophic types.

Planktic foraminifers

The distribution of planktic organisms in the surface water reflects modern oceanographic features and when compared with fossil communities permits a palaeoceanographic reconstruction to be made. The recent distribution of planktic fauna and in particular of planktic foraminifers in the TASQWA investigation area is not well-known. The necessity therefore exists for the documentation of the modern fauna and for a comparison to be made with physicochemical and biological parameters (such as primary production) on the sea surface. To this end, planktic foraminiferal and nannofossil associations will be examined, at all sites, by means of net-tow-catches, in different water depths, including near to the surface. The samples will be conserved in formalin for later faunistical analyses, and mass-spectrometric analyses of stable isotopes.

Coarse fraction and planktic foraminiferal analyses

The composition of the biogenic fraction in sediment samples was studied in terms of (i) the species assemblage of planktic foraminifers and other biota, reflecting the distribution of water temperature, salinity or nutrients, and (ii) of the other major components of the coarse fraction, depending on the source of the material but also of the preservational state of the sample, i.e. dissolution and other near bottom processes. At a number of deep (>4000 m) as well as of shallow stations (<1000 m) in all major areas, light-coloured, coarse to medium-sized foraminiferal sands were recovered. It can be inferred that these sediments have been affected by sediment winnowing and selective sorting due to the strong Western Boundary Currents that prevail on the South Tasman Rise and in large parts of the Emerald Basin and the Campbell Plateau

(McCave & Carter 1997). Thus, detailed information on the composition and origin of the sediments is needed before more advanced geochemical and faunal studies based on stable isotopes and transfer-functions are carried out.

Quantitative estimates of the fraction larger than 150 microns (μm) were made from the top centimetre of sediment from 21 multicorer and box corer stations and from 22 samples of Core SO136-011GC from the Challenger Plateau. This core was selected for a pilot study because it is situated in the warmer, mid-latitude subtropical waters with a relatively large diversity of planktic foraminiferal species. This allows taxonomic work and comparison of estimates on a large number of species.

A few millilitres of wet sediment were washed through a 63 μm mesh. The residue was dried at 60° C and sieved into five subfractions of 150-200, 200-250, 250-315, 35-400 and >400 μm. These subfractions were splitted with a microsplitter to at least 70 grains. In these splits all grains were identified and recorded following the categories: (1) Inorganic compounds (quartz, mica, oxides, lithic grains), (2) meiofauna (sponge spicules, ophiurid remains, pteropods, fish debris etc.), (3) siliceous tests (radiolarians, diatoms), (4) benthic foraminifers, (5) planktic foraminiferal debris, (6) intact planktic foraminiferal tests and (7) unknown. The shells of individual foraminifers were rated as intact and counted, when more than the half of the test was preserved. The relative abundances (in %) of the foraminiferal species and of the other components were calculated separately. Additionally, a foraminiferal dissolution index, expressed as the relative proportion of intact shells on the whole number of foraminiferal shells (i.e. the number of intact shells divided by the sum of intact shells and foraminiferal debris) was determined. However, some samples contain only a few grains in the largest size fraction due to the small sample volumes processed on board.

For the study of the planktic foraminiferal species all together 27 categories were encountered in the size fraction >150 μm, according to the taxonomic standards of CLIMAP. In combination with the coarse fraction analyses, these data are also intended to contribute to the global data base of foraminiferal transfer functions (TF) to better reconstruct palaeo sea surface temperatures (SST) and to fill gaps in particular areas of the Southern Ocean with high-quality data from box and multicorer core tops. Parallel counts from core top samples in the future will help to intercalibrate our census data. The main results of both, the coarse fraction and planktic foraminiferal analyses are listed in Tables I and II. Additionally, along the cruise track, surface water samples of 1-10 m^3 volume where continuously filtered using the ship's sea water supply system. During daytime up to 10 m^3 were run through a mesh of 63 μm. During the night we used a mesh sized of 20 microns. Due to the large volumes filtered, nearly all samples taken at daytime contained planktic foraminifera, hopefully in amounts for a statistical investigation of species distribution and stable isotope composition to be carried out in IOW and GEOMAR.

First results

Following the core descriptions light-coloured, nearly pure foraminiferal sands were found with high carbonate contents of up to 90% (see also carbonate analyses). These sediments mostly consist of larger, well preserved foraminiferal shells. We infer that strong bottom currents originating from branches of the Deep Pacific Western Boundary Current (DWBC) may have washed out at least parts of the clay and silt fraction to be of marine biogenic as well as terrigenous origin. A first regional study of the South Tasman Sea by Watkins & Kennett (1971a, b, and 1977) using RV ELTANIN deep-sea piston cores showed, that large-scale erosion in the deep South Tasman Rise (as well as in the Emerald Basin in the E) took place due to the intensification of Antarctic Bottom Water formation some 3-5 m.y. ago. Surprisingly, well-preserved foraminiferal faunas were found at some sites in the deep Emerald Basin down to 4500-5000 m water depth, i.e. far below the foraminiferal lysocline (e.g. SO136-116BX). Here, dark muds are dominated by siliceous remains like radiolarians and diatoms (see results from the coccolithophorids).

In order to better understand the effects of the bottom currents on the surface sediments, we determined the relative proportions of the small vs. large size fractions of planktic foraminiferal shells. A loss of the fine sediment is clearly seen in the size distributions and is exemplified in Fig. 13 at three contrasting sites.

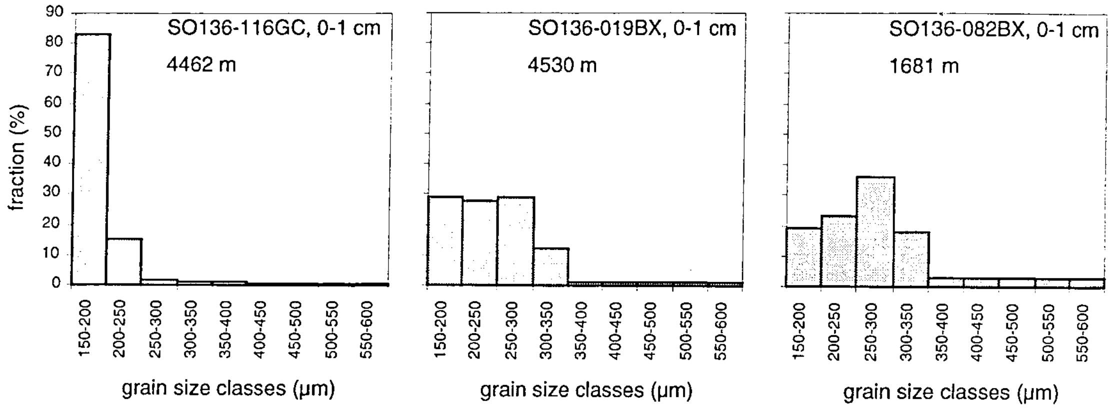

Fig. 13: Comparison of grain sizes of surface sediments of three contrasting sites.

Core SO136-116BX from the deep Emerald Basin shows a normal size distribution where small and juvenile species dominate the planktic foraminifers and only a few large specimens occur. SO136-019BX from the same water depth on the rise of E Campbell Plateau shows a totally different pattern, with a large number of specimens in the coarser fractions and planktic foraminiferal fragments, strongly corroded by bottom waters. However, a similar distribution pattern is also found at Site SO136-082BX (S Campbell Plateau), far above the foraminiferal lysocline, caused by strong bottom water currents that removed large parts of the fine fraction at this site.

The surface samples possibly affected by bottom current can be also characterised using a ternary diagram with the three end members of the proportion of the planktic foraminiferal fraction >250 µm, the one <250 µm, and the abundance of foraminiferal fragments (Fig. 14). Sandy sediments generally lack a large part of planktic foraminiferal debris which results in relatively low fragmentation indices. Obviously, fragments are washed away or dissolved preferentially. In contrast, Station 19 from 4500 m water is less affected by bottom water currents as it contains a large amount of foraminiferal fragments. However, extremely fragmented foraminiferal faunas were also found in both, the surface sediments and downcore at the shallow sites north-west off New Zealand on the Challenger Plateau. This observation is consistent with evidence based on $\delta^{13}C$ in planktic foraminifers (Swanson & van der Lingen 1997) indicating that a high local flux of organic carbon due to local upwelling in this area may result in extremely corrosive bottom and porewaters.

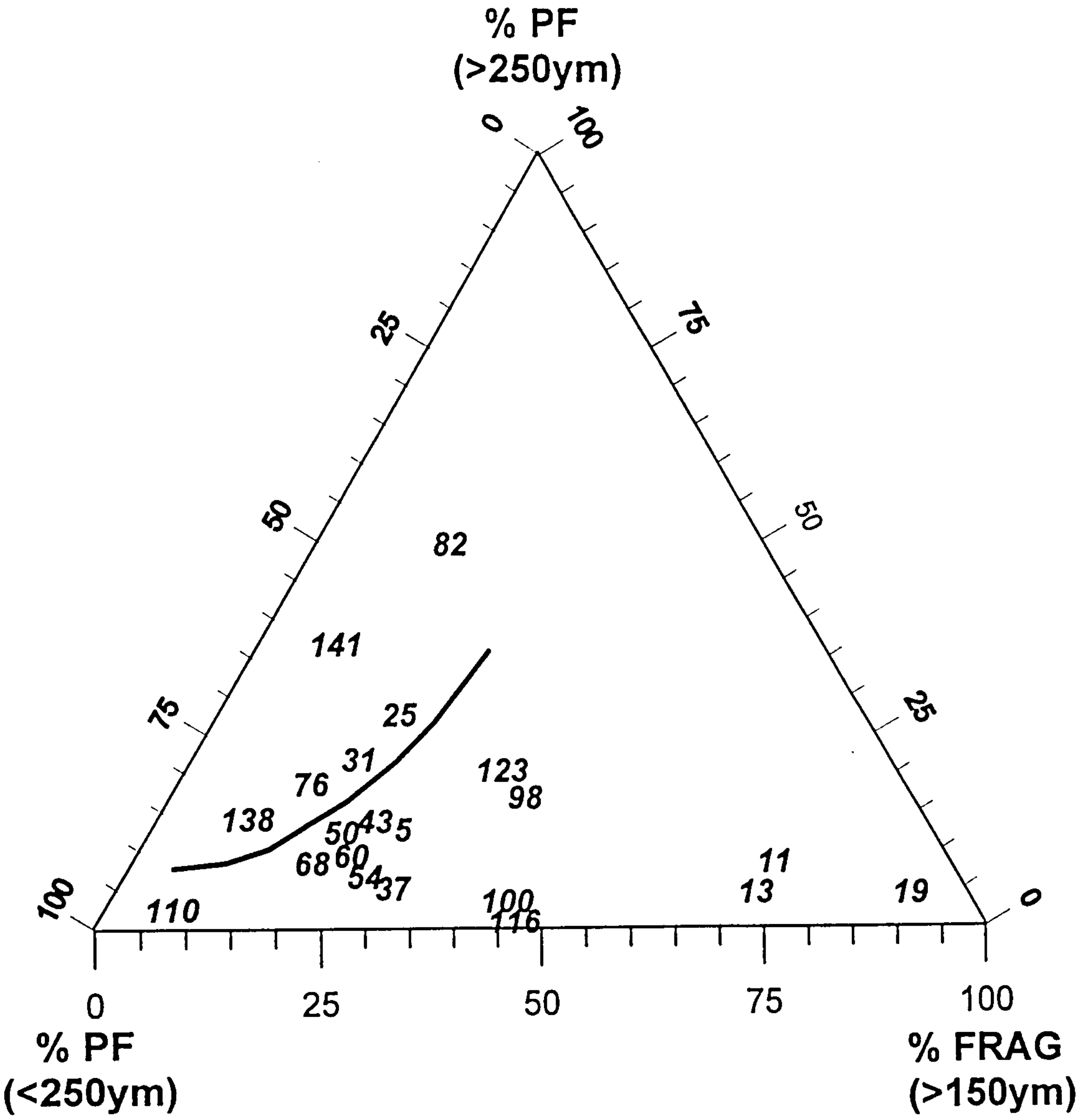

Fig. 14: Ternary diagram of planktic foraminiferal size classes and percentages of fragmentation in surface sediments. Numbers indicate sampled sites.

It is evident that despite shallow water depths, along the steep margin of the Campbell Plateau, the fine fraction may be washed away by the strong bottom currents due to the DWBC. Our data from the foraminiferal pilot study is in broad agreement with the core descriptions, where a separation was made between fine to medium foraminiferal sands vs. foraminiferal oozes. This classification fits well with the line given in Fig. 14. A granulometric study of foraminiferal shells on selected time slices may provide more detailed information on the intensity of the Pacific's DWBC in the past.

Foraminiferal investigations on core top samples

In broad agreement with Weaver *et al.* (1997) and Thiede *et al.* (1997) the distributions of planktic foraminiferal species show a general meridional pattern with increased abundances of the subpolar to polar species to the south. These species are: *Neogloboquadrina pachyderma* (sinistral), *Turborotalia quinqueloba* and *Neogloboquadrina pachyderma* (dextral). However, as far south as 55° S, *Globigerina* *bulloides*, and to a lesser degree *Globorotalia inflata* were also found in significant abundances. It has to be kept in mind that these samples may have been affected by bottom currents. Further examination of samples from these areas is necessary before they can be used as a basis or application of transfer-function analyses. At 55° S we found also a number of "Wurstkammer"-formed *N. pachyderma* (Hommers 1998). *Turborotalia quinqueloba* generally was found in both, right-coiling and left-coiling forms.

Foraminiferal investigations downcore

23 sediment samples were taken from Core SO136-011GC from the Southern Challenger Plateau. These samples parallel those of the XRD and calcium carbonate analyses (Fig. 15). This particular core was chosen in order to examine in more detail the changes in the relative abundances in the subtropical to subpolar latitudes where species diversity is somewhat higher than in the high latitudes where the variability in the abundances is mostly confined by only 2-3 species. As evident from the core top study at Site SO136-011GC (SO136-013BX at the same site) up to eight species occur in a significant number i.e. with more than 2 % in a sample. These species are (listed in the order of their estimated temperature preferences from "cold" to "warm": *N. pachyderma* (sinistral), *T. quinqueloba, N. pachyderma* (dextral), *Globigerina bulloides, Globorotalia inflata, Globorotalia crassaformis* and *Globorotalia truncatulinoides*. We noticed that in many cases specimens of the latter two species are not easy to separate from each other, consistent with observations from a larger area of the Southern Ocean Some affinities with the species *Globorotalia crassula* were also found, making these species a complex group. Generally, we found in Core SO136-011GC a relatively constant abundance of these taxa of about 5 %, however, specimens downcore show increasing flattening of the umbilicus and a more rounded periphery and an generally more robust character that makes it to look more like the *Gt. crassaformis*. Their relative species abundances of the entire assemblages downcore are shown in Fig. 15, together with the records of calcium carbonate content and foraminiferal fragmentation.

A first run of the foraminiferal data with a transfer-function (TF) to estimate palaeo-sea surface temperatures (SST) was made on board using an update of the global data base of Brown University and the Modern Analogue Technique. The first results are:

- Although this TF provided more 1200 modern core top assemblages as possible analogues to the fossil assemblages, similarity coefficients were low for most of the samples.
- SST estimates were generally too warm as the most similar assemblages were found further in the North of the Site SO136-011GC at 35-40° S.

For instance the relatively high abundances of *T. quinqueloba* in the middle sections of the core could not be found as analogues in the function applied, possibly due to the lack of samples from this area. However, the data of Thiede *et al.* (1997) collected specifically in the Southwest Pacific area may give different results, as it includes also some samples with higher abundances of this species. Further work on the calibration of available data sets and TFs for this particular area will also incorporate new census data from RV SONNE cruise SO136 core tops that were checked by grain-size analyses.

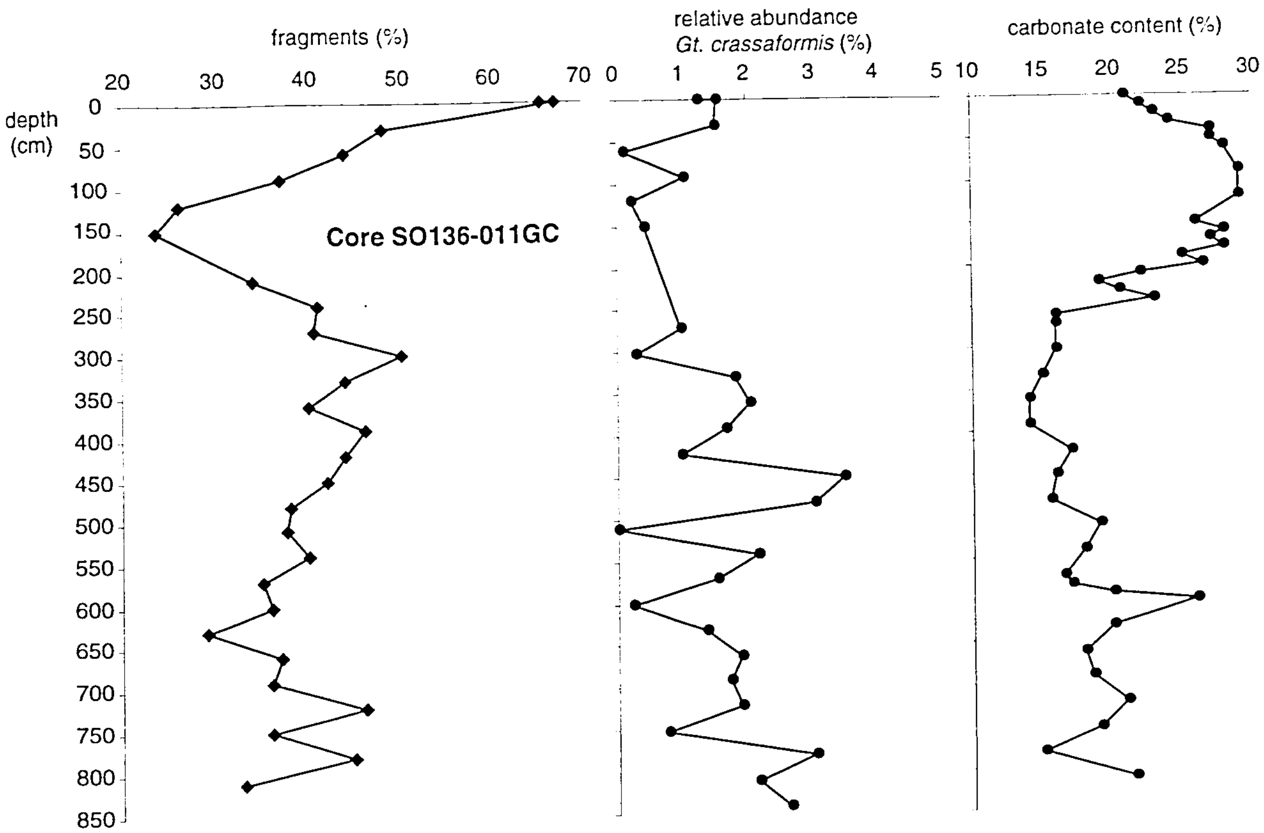

Fig. 15: Downcore plots of percentages fragmentation, relative abundance of *Gt. crassaformis* and carbonate content of Core SO136-011GC.

8.2.2 Benthic biota

Benthic foraminifers

Since the taxonomic and palaeoecological papers of Corliss (1979 a-c), only Nees (1994, 1997) published recently some advanced data on the interpretation of benthic foraminiferal assemblages in deep-sea cores in response to the glacial and interglacial dynamics of the Southern Ocean off of Australia and New Zealand. Up to now, no data exist on the distribution of living benthic foraminifers in this area. As a result, the interpretation of faunal fluctuations is still problematic for this ocean realm.

Thus, our main objectives during the cruise are first, the determination of standing stocks and the structure of assemblages of living foraminifers within the different environments and second, the application of environmental zonations of modern populations for the interpretation of fossil assemblages. Surface samples (0-1 cm) were taken from box cores (400 ccm) or multicores (78 ccm) at all stations. Depth profiles down to 5 cm below sediment surface were taken at 500 m, 1000 m, and 2000 m water depth. Living forams are stained with Bengal Rose in the samples for the detection of standing stocks. At Munich University, the samples are analysed for the fractions >250 µm and 63-250 µm, and dead and living (stained) foraminifers respectively.

Preliminary results from ~30 ccm unstained subsamples

Challenger Plateau

Due to small sample size in multicorers, sediments were stained directly without checking subsamples for foraminiferal content.

Campbell Plateau

In all samples recovered on the eastern Campbell Plateau, the genera *Bulimina, Uvigerina* (not! *U. peregrina*) and *Trifarina* are most prominent in the fraction >63µm. Spinosity is extremely developed in the sculpture of Buliminids and Uvigerinids, presumably in response to the well sorted, coarse grained sandy sediments derived from near bottom currents and occasional winnowing. Large agglutinated foraminifers are abundant (*Saccorhiza, Rhabdammina, Hyperammina, Jaculella*).

On the western Campbell Plateau down to 1000 m the assemblages are somewhat similar to the eastern transect. However, below 1100 m water depth, resuspension and winnowing increases. Sediments are coarse grained, well sorted foraminiferal sands. Terrigenous matter increases, standing stocks are lowered, and epibenthic genera such as *Cibicides* and *Cibicidoides* contribute to the assemblages of mainly Buliminids and Uvigerinids. *Trifarina* is very rare in comparison to the western Campbell Plateau, and also the large agglutinated taxa decrease near to zero at the stations with most intensive winnowing. Sessile monothalamous foraminifers (gen. indet.) with large sponge spines agglutinated are found on hard substrates only. These clearly duplicate the life style of *Rupertina stabilis* or *Saccorhiza ramosa.*

Below 4000 m water depth, and within more fine grained sediments and increasing siliceous matter, the standing stocks are still quite low. *Saccorhiza, Rhabdammina, Cyclammina, Bathysiphon, Labrospira,* and *Jaculella* are found in the size class >250 µm.

Emerald Basin

As given from the downslope profile at the Campbell Plateau, silt and clay increases, as do siliceous residuals from diatoms, radiolarians and sponges. The standing stocks are high, with highly diverse assemblages (*Ammolagena, Crithionina, Cylammina, Fissurina, Guttulina, Gyroidina, Oolina, Reophax*). Species of the genera *Melonis* and *Epistominella* are considered to indicate high benthic fluxes derived in short pulses from high local primary productivity.

South Tasman Rise

Rotaliid and miliolid foraminifers are rare at the rise. Within the white, sorted foraminiferal sands, agglutinated foraminifers are even very rare and consist of forms of agglutinated calcareous tests only (*Reophax calcareus* etc.). Standing stocks are low, and *Cibicidoides, Pyrgo*, and *Epistominella,* build up an assemblage dominated by epibenthic or facultatively epibenthic genera. Some excellently preserved *Laticarinina pauperata*, and some fractured specimen of a very large rotaliid with buliminid aperture were found in the samples, indicating some habitats defined to sessile and infaunal habitats. In the north, *Uvigerina* and *Melonis* are found again within sediments with higher contents of silt and clay.

Ostracodes

TASQWA ostracode studies are focused on two primary objectives, a) the recovery of as many deep-water taxa with soft-parts intact as possible, and b) the establishment of partition coefficients for living representatives of 3 target taxa (*Philoneptunus, Krithe, Cytheropteron*) and the application of the resultant data to downcore, palaeothermometric estimates of latest Quaternary bottom water temperature fluctuations. The use of the epi-benthic sledge (EBS) to recover live ostracodes has been very successful and as a result taxonomic revision of a number of key, cosmopolitan and endemic taxa will be possible. Preserved subsidiary samples from the active layer of the box corer (BX) have also been taken at most stations, however the small volume of sediment available from this device means recovery of live ostracode specimens occurs less often than for sledge concentrates.

Challenger Plateau

The selected sites (Lat. 42°17.29/Long. 170°00.11 to Lat. 43°20.10/Long. 164°50.15) contrast with more northern parts of the Challenger Plateau (previously sampled by GRAINZ, and the former NZOI), in that there is a progressive increase in detrital sedimentation and a consequent reduction in carbonates. The anticipated result is that biogenic carbonate remains will show the effect of more severe dissolution in the south. Because many of the sediment samples are >63 µm (which is coarser than the fraction removed by washing), large volumes of concentrate have had to be preserved. Estimates of both the number of specimens and the diversity of living species will be conservative because of the dilution effect of the detrital sediment and the time required to scan a representative sample.

A preliminary list of dominant living components of the benthic non-ostracode macro- and meiofauna includes; molluscs, pteropods, scaphopods, stalked barnacles, brittle stars, polychaetes, hermit crabs, crabs, copepods and amphipods.

A preliminary list of dominant components of the benthic ostracode fauna includes:

Myodocopida (spp. *)	*Argilloecia* (3 species)
Bairdioidea (1 species *)	*Krithe* (spp.)
Cytherella (1 species *)	*Philoneptunus* (1 species)
'Microloxoconcha' (1 species *)	*Henryhowella* (1 species)
Ambocythere (2 species *)	*Trachyleberis* (1 species)
Legitimocythereis (1 species *)	*Taracythere* (2 species)
Cytheropteron (2 species)	*Bradleya* (3 species)
Bythocypris (1 species)	*Xestoleberis* (spp.)
Polycope (1 species)	

(* = found with soft anatomy intact)

Campbell Plateau

Samples from the Campbell Plateau washed for Ostracodes are foraminiferal, medium-fine sands and muddy sands taken along a E-W transect from Lat. 50°51.10S/Long. 176°53.20S to Lat. 50°09.80S/Long. 173°22.00E. These sediments and the water depths (from 4530 m to 560 m) correspond with GRAINZ sites on the upper slopes of the southern flank of the Challenger Plateau in the Tasman Sea. There are some preliminary contrasts apparent between these two assemblages. The eastern Campbell Plateau assemblage is dominated by species of *Bradleya*. Tasman Sea assemblages tend to have a more equitable distribution of numbers across taxa such as *Krithe, Legitimocythereis, Cytheropteron, Henryhowella* and *Bradleya*. It is also interesting to note that one widely distributed species, *Bradleya pygmaea* has not been found on the Campbell Plateau. In general the assemblages are well-preserved and the effects of dissolution and/or abrasion are not pronounced.

A preliminary list of dominant living components of the benthic non-ostracode macro- and meiofauna includes; molluscs, bryozoans, sponges, scaphopods, barnacles, brittle stars, polychaetes, hermit crabs, copepods and amphipods.

A preliminary list of dominant components of the benthic ostracode fauna includes:

Myodocopida (spp. *)	*Cytheropteron* (spp.)
Bradleya (3 species *)	*Bythocypris* (1 species)
Bythoceratina (1 species *)	*Henryhowella* (1 species)
Macrocypris (1 species *)	*Polycope* (spp.)
Argilloecia (spp. *)	*Bardiid* (1 species)
Krithe (spp. *)	*Jonesia* (1 species)
Xestoleberis (spp. *)	*Clinocythereis* (1 species)
Taracythere (1 species *)	*Aversovalva* (1 species)
Cytherella (1 species *)	*Pontocypridinid* (1 species)
Legitimocythereis (1 species *)	*Hemicytherid* (1 species)
Philoneptunus (1 species *)	*Eucythere* (1 species)
'Trachyleberis' (1 species *)	*Cytheralison* (1 species)
'Microloxoconcha' (1 species *)	
Paradoxostomid (1 species *)	

(* = found with soft anatomy intact)

Emerald Basin

Two stations (SO136-110BX, SO136-116BX) have been taken at water depths of between 4000 m and 4400 m in sandy mud. These sediments are dominated by siliceous biogenic remains including radiolarians and spines (which make washing very difficult because they form a flocculent in the suspension). For each box core, residue remaining after all sampling requirements met was cut into 5 cm horizontal slices and washed, decanted and wet sieved to concentrate the fraction >200 µm. An average 3 litres of sediment from each core cut was washed resulting in a >200 µm fraction of 150-300 ccm. Major contributions to that fraction were from planktic foraminifers, mica flakes (and other unidentified, angular green detrital grains), large radiolaria, benthic foraminifers, diatoms and arenaceous worm tubes. Ostracode valves are extremely rare and no specimens with soft parts intact were recovered.

Consideration must be given to the possibility that the Ostracodes represent a thanatocoenosis, especially in view of the fact that clearly there is considerable down-slope movement of detrital material eroded from the metamorphic rocks of south-west New Zealand. The fact that juvenile ostracode valves were recovered, could also be interpreted as indicating that fauna as a biocoenosis since these valves are very quickly destroyed during reworking. The presence of two perfectly preserved valves of the delicate spinose ostracode *Legitimocythereis* would appear to be sufficient evidence to conclude that at least a portion of the depleted assemblage is representative of a biocoenosis.

Valves of the following ostracodes have been recovered:

Legitimocythereis sp. (adults + juvenile)	*Krithe* spp. (adults + juvenile)
Henryhowella sp. (adults + juvenile)	*Bradleya* sp. (juvenile only)
Bythocypris sp. (juvenile only)	

South Tasman Rise

Surface water and the 'active' layer from three box cores from the South Tasman Rise were examined for ostracodes. Sample depths ranged from 3100 to 1500 m approx., and sediments were predominantly well sorted, foraminiferal medium-fine sands or foraminiferal muddy fine sands (SO136-161BX). In all samples ostracodes were conspicuously absent. Where recovered, the podocopid assemblage is depleted with respect to total numbers and diversity. Most species exhibit the effects of dissolution and from abrasion, some shells (especially those of *Krithe*) being chalky and fragile. In fact, a component of the assemblage was probably lost during washing as a result of this characteristic. Where recovered, live specimens are extremely rare. Taxonomically, the assemblage is quite distinct from that recovered on the Challenger and Campbell Plateaus.

A preliminary list of dominant components of the benthic ostracode fauna includes:

Myodocopida (ssp. *)	*Henryhowella* (1 species, juv. + adult)
Pseudocythere (1 species, adult *)	*Arcacythere* (1 species, juv.)
Polycope (1 species, adult *)	*Taracythere*(1 species, adult)
Ambocythere (1 species, adult)	*Bradleya* (2 species, juv. + adult)
Krithe (4 species, juv. + adult)	*Dutoitella* (1 species, adult)
Bairdiid (1 species, juv.)	sp. indet. (1 species, adult *)
Poseidonamicus (1 species, juv. + adult)	
Brachycythere / Glyphidocythere (1 species, juv. + adult)	
Echinocythere / Legitimocythere (1 species, juv. + adult)	

(* = found with soft anatomy intact)

8.3 Hydrography and hydrochemistry

Continuous hydrographic survey (oxygen, temperature and salinity profiles) from surface water to the sea floor will be carried out using a CTD-system equipped with Niskin water sampling bottles. Measurements are transmitted to the ship in real-time, which allows for water sampling during profiling. CTD-data is used to position hydrographic fronts and to distinguish different water masses in vertical water column profiles. Water will be sampled for phosphate, stable isotopes and trace metal analyses, parallel sediment surface and sediment core analyses will be carried out for both stable isotopes and trace metals as well. Therefore, to calibrate sediment and water proxy data deep water samples are of particular interest.

8.3.1 CTD-measurements

A primary aim of the TASQWA project is to reconstruct the palaeoceanography of the Southern Tasman Sea and SW Pacific sector of the Southern Ocean. In order to unravel the past an understanding of the modern day oceanographic regime is required. Hence, a continuous hydrographic survey (temperature, salinity, and oxygen profiles) from surface water down to the seafloor was carried out using a Seabird CTD equipped with a rosette of 24 Niskin bottles. Collected CTD data has been used to distinguish water masses as well as position hydrographic fronts. The rosette was sampled for alkalinity, phosphate, stable isotope and trace metal analyses, and filtered for dinoflagellate cysts, diatom and nannoplankton collection.

Fronts and surface water masses

Three dominant surface water masses occur in the SW Pacific Region bounded by three oceanic fronts (Fig. 2 and Tab. 3). In the north of the region high salinity (35.7-35.8), nutrient poor Subtropical Surface Water (STSW) lies to the north of the Subtropical Front (STF) (Tab. 3). South of the STF nutrient rich, low salinity (34.5) Subantarctic Surface Water (SASW) occurs. SASW is bounded to the south by the Subantarctic Front (SAF) with fresh, cool Circumpolar Surface Water (CSW) occurring south of the SAF. CSW is in turn bounded to the south by the Antarctic Convergence/Polar Front (APF).

Tab. 3: Characteristics of major water masses and fronts of the Southwest Pacific

Water Mass	Abbr.	Depth (m)	Density	Salinity	Temp. (°C)	Oxygen	Silica
Subtropical Surface Water	STSW	Surface			>15		
Subtropical Front (Convergence)	*STF*		*Separates STSW from SASW at 15° summer surface isotherm*				
Subantarctic Surface Water	SASW	Surface			8-15		
Subantarctic Front	*SAF*		*Separates SASW from CSW at 8° summer surface isotherm*				
Circumpolar Surface Water	CSW	Surface			5-8		
Polar Front (Antarctic Convergence)	*APF*		*Separates CSW from Atarctic Water (AAW), with icebergs (< 5°C)*				
Thermocline Water		0 - 400		34.42 - 34.90	7.00-11.00	4.40-5.00	
Subantarctic Mode Water	SAMW	400-600	26.80-27.20	34.0-34.2	6-10	very high	very low
Antarctic Intermediate Water (S min)	AAIW	600-1450	27.20-27.35	34.50-34.36	3.20-7.00	3.20-4.70	
Circumpolar Deep Water (upper)	CPDWu	1450-2900	36.50-37.00	34.67-34.71	1.60-1.80	3.03-3.45	high
Circumpolar Deep Water (lower i; S max)	CPDWi	2900-3800	37.00-45.93	34.71-34.73	0.90-1.60	3.45-3.63	high
Circumpolar Deep Water (lower ii)	CPDWii	>3800	45.93-46.00	<34.71	0.55-0.90	4.70-4.80	high
Antarctic Circumpolar Current	ACC	0 - seafloor	various				
Weddell Sea Deep Water	WSDW				-0.30-0.00		
North Atlantic Deep Water	NADW		as for CPDWii				
Antarctic Bottom Water*	AABW						

* general term for cold water of Anarctic origin that spreads north into the major ocean basins

The intensity and positions of the STF and SAF are influenced by bathymetry. To the west of New Zealand, across the Tasman Sea, the STF hovers below Tasmania at 45° S (Orsi *et al.* 1995), upon reaching South Island New Zealand the STF follows the continental slope, and is known as the Southland Front (Fig. 2). Once reaching Chatham Rise the Southland Front continues east as the STF at approx. 43° S before becoming diffuse and looping south (Heath 1985; Carter *et al.* 1998). The STF shows some seasonal variation between 44° S in winter to 42° S in late summer (Chiswell 1994). West of New Zealand, across the Tasman Sea, the SAF is relatively unconstrained by bathymetry occurring between 53-55° S (Orsi *et al.* 1995). Within the New Zealand sector of the SW Pacific the SAF passes around Macquarie Ridge, and long the eastern flank of the Campbell Plateau turning east at about 55° S (Gordon 1972; Orsi *et al.* 1995). A less defined frontal flow also continues north along the Campbell Plateau margin, turning east at ~50° S (Bryden & Heath 1985; Carter *et al.* 1998) (Fig. 2). The SAF and APF nominally bound the north and south of the Antarctic Circumpolar Current (ACC).

Circulation

The ACC is a topographically steered, eastwards flowing, deep reaching current, with an average volume transport of ~130x106 m^3s^{-1} (Whitworth 1988). The main body of the ACC flows south of Australia, with a small part being deflected into the Tasman Sea as it nears New Zealand (Webb *et al.* 1991). As the ACC encounters Macquarie Ridge it also comes in contact with the DWBC. The ACC-DWBC paths are here controlled by bathymetry, with filaments of flow passing through gaps north and south of Macquarie Island, while the main body of flow passes around the end of Macquarie Ridge (Fig. 1). Part of this flow meanders into Emerald Basin combining with the gap filaments forming an intensified flow along the basin-plateau margin (Orsi *et al.* 1995). The subantarctic slope of Campbell Plateau results in topographic intensification of the ACC-DWBC, with the ACC turning once again eastwards south of the Bounty Trough, whereas the DWBC continues on its northward journey across the end of Bounty Trough and around the Chatham Rise (Warren 1973; Carter & McCave 1997).

Deep water masses

Underlying the surface waters of this region occurs Antarctic Intermediate Water (AAIW) with a depth range of ~600-1450 m. AAIW is formed by sinking at the APF, hence deepens away from the frontal zone, and is characterised by temperatures of 3-7° C and a salinity minimum of 34.36-34.5 (Tab. 3). AAIW moves unimpeded east of Chatham Rise and can be traced as far north as 15° S (Tomczak & Godfrey 1994). Subantarctic mode water (SAMW) can be found as an isothermal water mass overlying AAIW. SAMW occurs north of the SAF across the Campbell Plateau, which is considered to be an area of active formation.

Beneath AAIW lies a large northward flowing deep water mass, Circumpolar Deep Water (CPDW) described by Gordon (1975), which can be subdivided into three distinct units (Tab. 3); Upper CPDW, Lower CPDWi, and Lower CPDWii, which comprises the main body of DWBC flow. Upper CPDW occurs below AAIW to depths of ~2900 m, and is distinguished by an oxygen minimum and relatively low dissolved silica content. Lower CPDWi occurring between ~2900-3800 m, comprises a high salinity zone (34.72-34.73), which deepens northwards, indicative of the influence of North Atlantic Deep Water (NADW). Below 3800 m the colder, lower salinity Lower CPDWii occurs which comprises components of NADW, Weddell Sea Deep Water and Ross Sea Deep Water.

CTD-transects

Challenger Plateau (see Appendix A82)

Two CTD profiles were obtained on the Challenger Plateau (CTD 007 at 42.17° S, 169.50° E; CTD 010 at 43.26° S, 167.51° E). Both profiles are north of the STF, with surface water exhibiting characteristics of STSW. AAIW with its distinct salinity minimum constitutes the basal water mass in these profiles, with the deepest profile only extending as far as 1550 m.

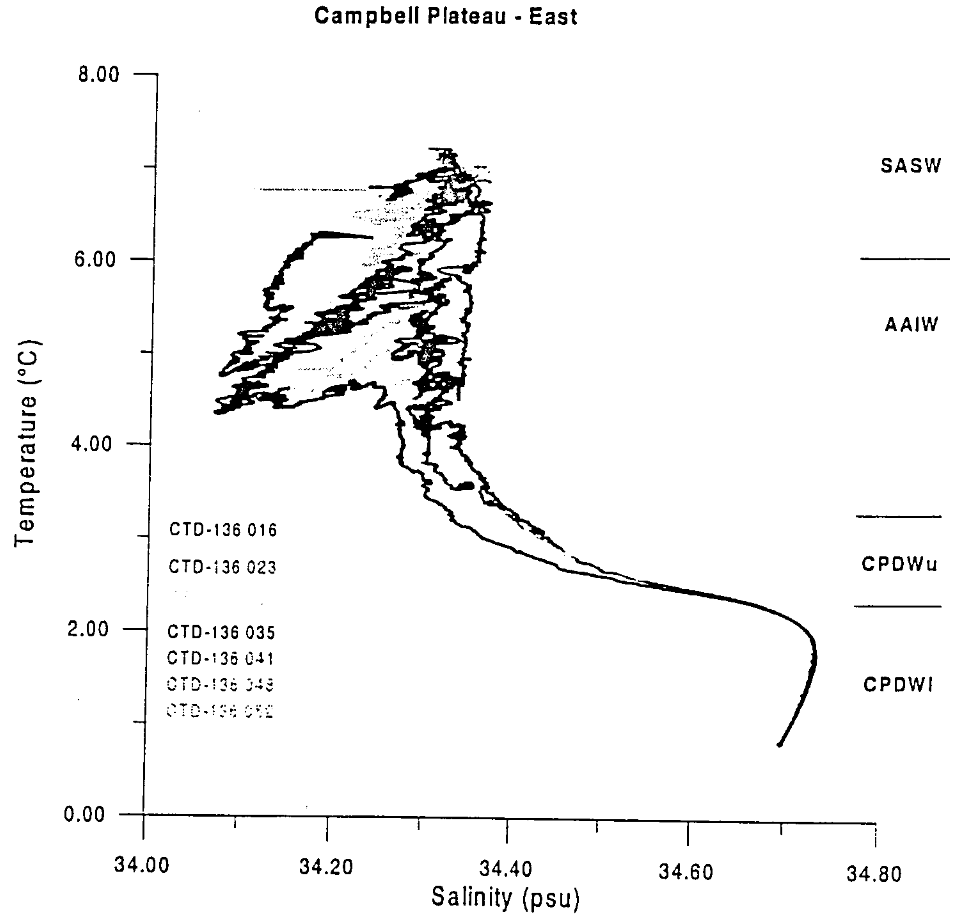

Fig. 16: Plots of salinity vs. temperature of the CTD stations on the E Campbell Plateau.

East Campbell Plateau (see Fig. 16 and Appendix A83)

A transect of 7 CTD profiles was completed for the eastern slope of Campbell Plateau between 50.09° S, 173.21° E and 50.50° S, 176.53° E. While the SAF was not crossed by this transect, the edge of an eddy probably associated with the frontal system and/or the widening of Campbell Slope in this location was encountered between CTD profile 016 and CTD profile 035. The SASW over Campbell Plateau exhibited deep surface water mixed layers, while the character of AAIW is quite diffuse. The deepest profiles at the edge of Campbell Plateau extended through Upper CPDW to Lower CPDW.

South Campbell Plateau and Emerald Basin (see Appendix A84)

This transect of 10 CTD profiles passes across the southern Campbell Plateau (53° 20'S; 169° 14'E) and down the subantarctic slope to 55° 50'S; 165° 10'E, before turning west into the Emerald Basin. Deep surface mixed layers continued to be exhibited in profiles from the Campbell Plateau (CTD 059 to CTD 096), with the upper 800 to 1000 m of the water column being warmer and more saline than those to the east. This result has also been recorded during NIWA surveys of the area suggesting this is not a short-lived phenomenon. The SAF was crossed between CTD 096 and CTD 102, placing it at approx. 56° S, and surface water temperatures less than 2° C suggest proximity to the APF. CTD profiles 104 and 114 from the Emerald Basin display characteristics indicative of being located within a filament of flow from the ACC which passes south of Macquarie Island.

South Tasman Rise (see Appendix A85)

A northwards running transect of 7 profiles was collected up the South Tasman Rise from 52° 48'S, 150° 36'E to 46° 33'S, 149° 04'E. The southernmost profile CTD 118 exhibits a shallow temperature minima characteristic of the Polar Frontal Zone. Whereas, the following three profiles (CTD127 to CTD 135) are consistent with a filamented SAF zone. The remaining three profiles lie north of the SAF and while the STF is not crossed by this transect the northernmost profile is approaching the STF zone. Deep waters are fairly consistent in all profiles with a dominant oxygen minimum occurring between 1000 and 1800 m.

8.3.2 XBT-programme

A long-term programme which is designed to evaluate the interaction between the SAF and the south-west shelf of Campbell Plateau, as well as to quantify flow variability across the Campbell Plateau was initiated in 1997 by NIWA. This survey is also conducted with particular reference to the cycle of upper water column stability and possible winter formation of intermediate waters within the Campbell Plateau region. This is achieved by a mooring array between 50° 15'S, 171° 30'E and 53° 30'S, 175° 10'E and seasonal CTD surveys. Ships of opportunity are also used to gather data via launching of Expendable bathythermographs (XBT's), resulting in the collection of time-series data sections of temperature as a function of depth down to 600 m. Two such XBT profiles were run on this cruise, with XBT's being launched every 20 nm. One profile south-east across Campbell Plateau between 48° 00'S, 167° 46'E and 50° 52'S, 176° 54'E. A second profile was run in a south westerly direction between 50° 08'S, 172° 35'S and 53° 12'S, 169° 22'E. These profiles showed the continued existence of a deep mixed layer across Campbell Plateau, resulting from winter turnover, which has yet to break down. This information will form part of a time-series of subsurface sea temperature around New Zealand in order to understand interannual variability of the oceanic temperature field near New Zealand.

8.3.3 Hydrochemistry

Trace metals, phosphate and stable isotopes

Throughout all working areas, samples for trace metal analyses and stable isotope measurements were collected from all CTD depths, samples for isotope analysis were stabilised with $HgCl_2$ and samples for trace metal analysis acidified (pH < 2) and stored at + 4° C. To calibrate the salinity record of the CTD, some depths were sampled for salinity measurement as well. The bottom-most Niskin bottle was transferred under a clean bench where it was sampled for Cd and phosphate analysis. Water samples for Cd were collected in precleaned 1 l PP-bottles, acidified with 3 ml conc. HCl, sealed and stored in plastic bags at + 4° C. On a variety of CTD profiles, alkalinity was determined measuring pH with a 540 GLP WTW pH-meter.

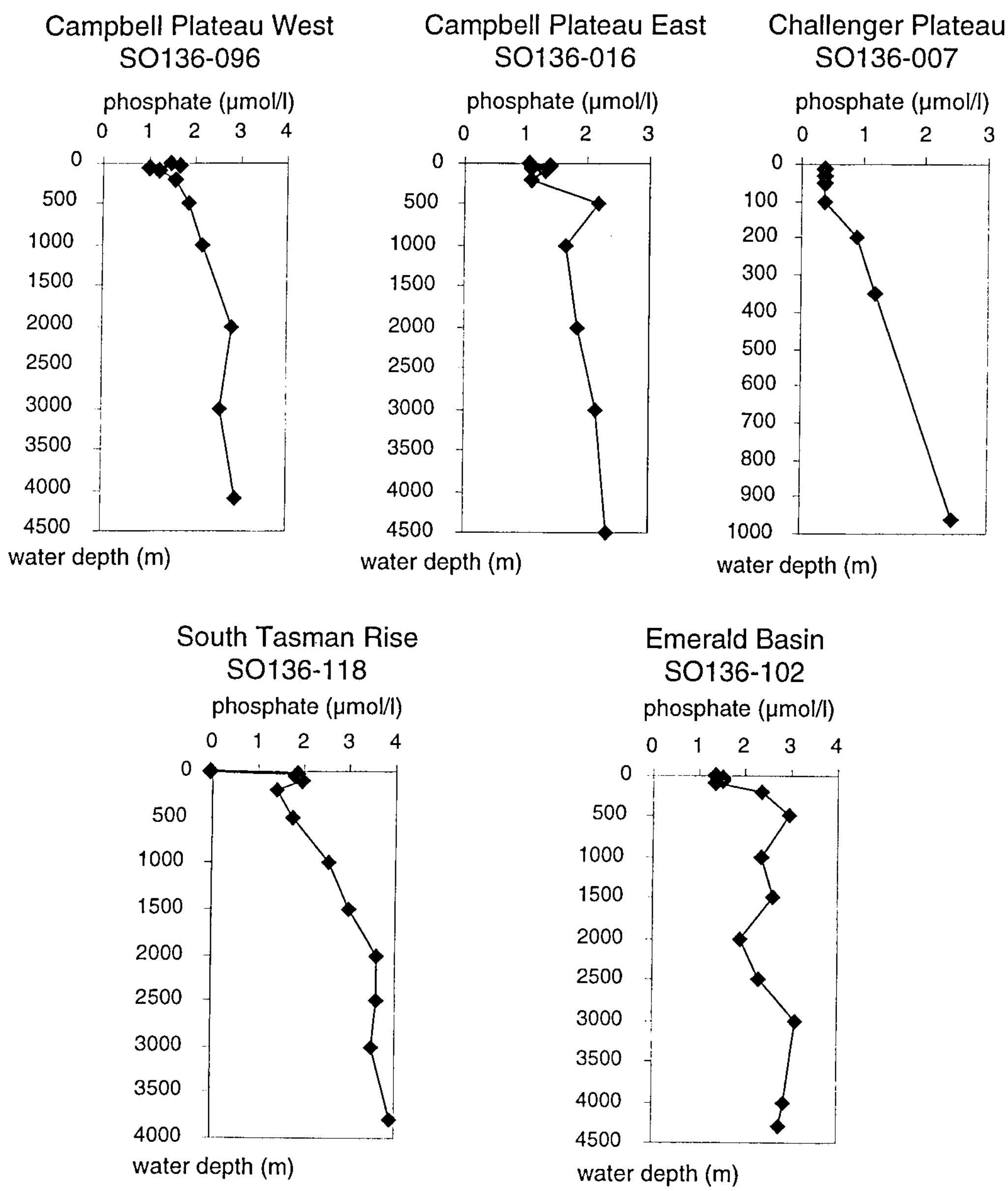

Fig. 17: Typical profiles of phosphate concentration through the water column.

Phosphate was analysed on all water samples from the CTD-Niskin bottles and on overlaying water from the multicorer. Samples that could not be analysed directly were temporarily stored deepfrozen. Analyses were carried out with a Dr. Lange photometer (LW2), measuring the extinction of molybdophosphate at 880 nm. Fig. 17 shows some typical phosphate profiles of all working areas.

Organic tracers

The aim of the EU project "*Global mass balance of persistent semi-volatile organic compounds - An approach with PCB as an indicator*" is to quantitatively describe the global fate of PCBs. The key questions to be answered are:

1. Where will the PCBs end up, i.e., in deep-sea water, coastal sediments, soil or chemically transformed to other substances and what is the rate of decrease in remote areas on the globe for different PCB congeners?

2. At what rate are PCBs being removed from the global environment?

A global mass balance model will be developed in which the globe will be divided into sections where climate affects all processes relevant to the fate of PCBs. The inventory of exchange between burial and chemical reactions within these compartments will be assessed along with a determination of degree of uncertainty of these estimates. The project will consist of 8 sub-projects, each focusing on key processes in the global mass balance of PCBs including a measurement campaign of ocean-, land- and air-processes and development of reliable estimates of emissions and degradation rates of PCBs in air and other matrices.

The occurrence and net downward fluxes of PCBs in the Pacific Ocean will be studied in the sub-project OCEAN. In total, 30 sediment trap samples will be analysed. In addition, concentrations of PCBs in surface water (both suspended particles and dissolved), deep-sea water and in deep-sea sediments will be done during a cruise in the North and South Pacific. In near surface waters a new technology utilising the $^{234}Th/^{238}U$ disequilibrium will be used to estimate the export flux of particle bound PCBs to deeper water layers. This type of sample will be taken at each PCB-sampling location during the Pacific cruises.

Sedimentation to deep-sea: presently only a few measurements of PCBs in sediments in remote ocean areas exist and so far no accompanying measurements of dissolved concentrations of PCBs in surface waters from where sediment originates. It is necessary to develop a relationship between dissolved PCB concentration and concentration of PCB in sediments at various ocean realms. A few such accompanying measurements need to be done at different remote ocean areas. One of the contracting partners recently conducted such studies in several cruises in the North and South Atlantic which will soon generate published data. Presently the largest gap of knowledge is the Pacific Ocean, where two sampling cruises need to be done for measurements in surface and deep-sea water (depth-profiles), sediment and sediment traps.

The Kiel organic chemistry group is studying the long- and short-term variation in the vertical flux of particulate organic compounds. Major aim is to get information about the biological influence on chemical composition and on degradation and changing processes of organic particles in the water column.

During RV SONNE cruise SO136, investigations have been carried out on formation and transport of natural occurring organic substances (amino acids, alkenones) and on anthropogenic tracers (hydrocarbons like PCB, PAH and pesticides). Large volume samples of surface SPM will be collected while the ship is steaming using the ship pumping system.

The following questions are of special interest:

- Are the changes in the composition of organic matter flux in relation to time, space, particle size and physical or biological events in the surface layer?
- How does the composition of particulate and dissolved organic matter change with water depth?
- What are the particulate 'biomarkers' that may give information about biological composition of the remote ocean?
- What kind of vertical concentration profiles do exist for dissolved anthropogenic tracers (e.g. PCB) and what is the concentration in suspended particulate matter (SPM)?
- What are the relations between organic tracers, trace elements and radio-isotopes?

Working programme

Underway samples from the surface water were taken continuously by the "RV SONNE Pumping System". Material for the analysis of organic biomarkers and anthropogenic tracers will be taken. The material will be analysed in the clean-room laboratory in IfM Kiel.

Station work

At selected stations water and sediment samples were obtained. Vertical profiles of various compounds in the water column are archived taken with the Kiel *in situ* pumps (KISP).

Sediment samples were collected with box corer for the determination of organic compounds at mooring positions: at Stations SO136-110, 56°40.87'S, 160°14.87'E, 3907 m water depth and SO136-123, 52°57.98'S, 151°08.23'E, 4196 m water depth. One cm sediment slices of the upper 4 cm (and 3 cm slices down to 10 cm sediment depth) were taken from the inner sediment core of a multicorer tube, wrapped in aluminium foil and stored in the freezer.

Vertical profiles with KISP were obtained at Stations SO136-108, 56°45.18'S, 159°32.86'E, 3974 m water depth and SO136-122, 52°48.79'S, 150°36.29'E, 3887 m water depth. At each of the two stations, one water pump was deployed at 100 m water depth, a second one at the oxygen minimum layer determined via the CTD-profile (700 m at Station SO136-108 and 1000 m at Station SO136-123) and a third and fourth pump at 3000 m and 3020 m water depth, where the minimum in water temperature starts. All pumps were set to a total pumping time of 6 hours to obtain a maximum sample volume. Filters (SPM) were stored deepfrozen, XAD-columns (dissolved material) kept at + 4° C. Underway samples from the surface layer were taken on three transects:

- between Stations SO136-055 and SO136-056 from 50°10'S, 173°21'E to 53°20'S, 169°15'E,

- between Stations SO136-117 and SO136-118 from 55°28'S, 158°49'E to 52°49'S, 150°37'E,
- between Stations SO136-162 and SO136-166 from 46°33S. 149°05E to 44°38'S, 148°32'E.

Again, filters were stored deepfrozen and XAD-columns at + 4° C.

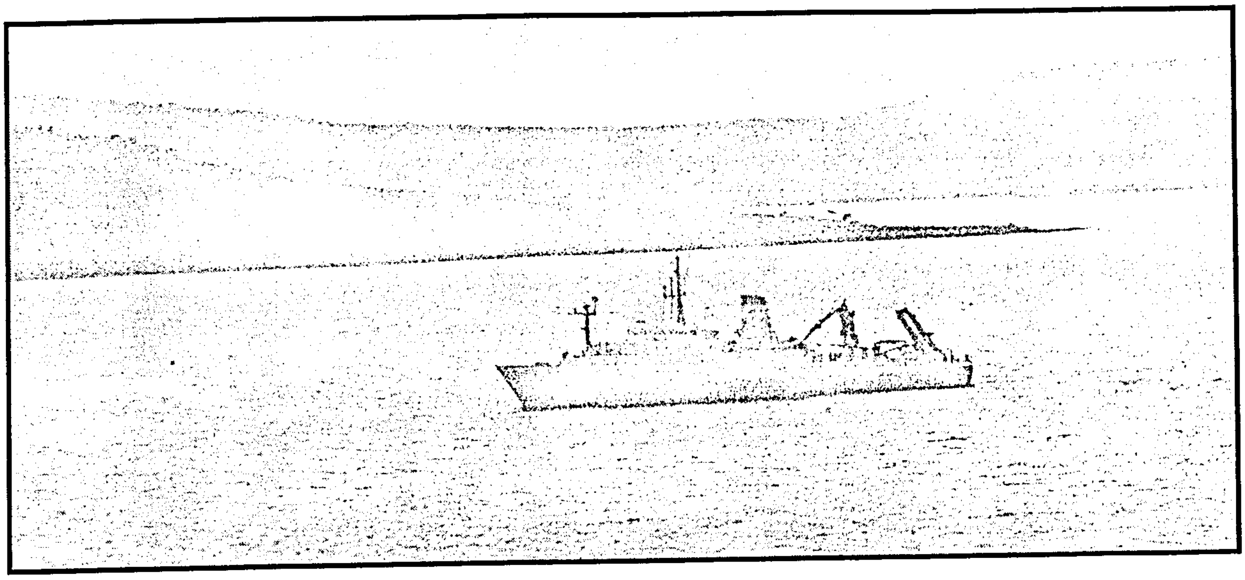

Fig. 18: RV SONNE on the River Derwent on her way to the harbour of Hobart in the morning of the 12. November 1998 (courtesy L. Armand).

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Appendix

A1:	Scientific shipboard party of TASQWA
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Scientific shipboard party of TASQWA

Jörn Thiede	**Chief scientist**/pl. forams	GEOMAR/AWI
Stefan Nees	Benth. forams, fossil	GEOMAR
Alexander Altenbach	Benth. forams, recent	LMU
Nils Andresen	Photospektrometry	GEOMAR
Claire Findlay	Fossil nannoplankton	CRC
Peter Hill	PARASOUND, HYDROSWEEP	AGSO
Will Howard	Pl. forams/transf. funct.	CRC
Thomas Jellinek	Ostracodes	FSF
Thomas Jurkschat	Diatoms	BGR
Elisa Laurent	N, C isotopes diatoms	DGO
Gerrit van der Lingen	Sedimentology	GRAINZ
Anja Müller	Trace metals	GEOMAR/ANU
Helen Neil	Sedimentology/CTD	NIWA
Ian Probert	Alkenone/nannopl.	LMSE/BBM
Wilma Rehder	Photogr./Xray techn.	IfG Univ. Kiel
John Reijmer	Carbonate mineralogy	GEOMAR
Rebecca Rendle	$^{30}Th_{ex}$dating/Xray.diffr.	GEOMAR
Sven Roth	Photospektrometry	GEOMAR
Andres Rueggeberg	Sedimentology.	GEOMAR
Ortrud Runze	Laboratory techn.	GEOMAR
Hartmut Schulz	Pl. forams/transf. funct.	IOW
Marcus Schumann	Technician	MARISCOPE
Arne Sturm	Stab. isotopes /MST	GEOMAR
Kerry Swanson	Ostracodes	CUC
Claudia Willamowski	Cd/Ca,trace elements	GEOMAR

AGSO	Australian Geological Survey Organisation, Canberra
ANU	Geology Department, The Australian National University, Canberra
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven
BBM	Laboratoire de Biologie et Biotechnologies Marines, Caen
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover
CRC	Antarctic Cooperative Research Center, Hobart
CUC	Geology Department, Canterbury University, Christchurch
DGO	Département Géologie et Océanographie, URA CNRS 197, Talence
FSF	Forschungsinstitut Senckenberg, Frankfurt/Main
GEOMAR	Forschungszentrum für Marine Geowissenschaften, Kiel
GRAINZ	Geoscience Research and Investigations New Zealand, Christchurch
IfG	Institut für Geowissenschaften, Christian-Albrechts-Univ., Kiel
IOW	Inst. für Ostseeforschung, Warnemünde
LMSE	Laboratoire de Modélisation de Climat et de l'Environnement, Gif-s.-Yvette
LMU	Inst. für Paläontologie und Historische Geologie, LMU München
NIWA	National Institute of Water and Atmospheric Research, Wellington

The ship's crew of RV SONNE cruise SO136

Hartmut Andresen	**Master**
Stefan Bülow	1st mate
Lutz Mallon	1st mate
Wolfgang Sturm	radio officer
Dr. Ingo Naeve	physician
Uwe Thaysen	1st engin.
Eberhard Bochnik	2st engin.
Uwe Schade	2st engin.
Uwe Rieper	electrician
Hilmar Hoffmann	chief. electron.
Kurt Stammer	electron.
Rudolf Angermann	sys. operator
Jens Grigel	sys. operator
Peter Schymatzek	deck mechanics
Klaus Teichert	mechanician
Hans g. Becher Bethge	mechanician
Roland Teske	mechanician
Volker Blohm	mechanician
Horst Müller	cook
Adolf Cwienk	cook's mate
Werner Slotta	1. Steward
Werner Müller	2. Steward
Peter Eller	2. Steward
Karl-Heinz Lohmüller	boatswain
Hans-Jürgen Vor	sailor
Siegfried Becher	sailor
Jürgen Kraft	sailor
Günter Lude	sailor
Herman Röpti	sailor
Peter Hadamek	sailor

RF Reedereigemeinschaft Forschungsschiffahrt GmbH

Haferwende 3

D-28357 Bremen

Germany

Postal addresses of the participating institutions and agencies:

Germany

AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung, Columbusstraße, D-27515 Bremerhaven
GEOMAR	Forschungszentrum für Marine Geowissenschaften, Wischhofstr. 1-3, D-24148 Kiel
IfG	Institut für Geowissenschaften, Christian-Albrechts-Universität, Olshausenstr. 40, D-24118 Kiel
IOW	Institut für Ostseeforschung, Warnemünde, Seestr. 15, D-18119 Rostock-Warnemünde
LMU	Institut für Paläontologie und Historische Geologie, Ludwig-Maximilian-Universität, Richard-Wagner-Str. 10, D-80333 München
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe, Stilleweg 2, D-30655 Hannover
FSF	Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt/Main

Australia

AGSO	Australian Geological Survey Organisation, Constitution Avenue, Canberra, ACT 2601
ANU	Geology Department, The Australian National University, Canberra, ACT 0200
CRC	Antarctic Cooperative Research Center, Hobart, University of Tasmania, GPO Box 252C, Hobart, TAS 7001

New Zealand

NIWA	National Institute of Water and Atmospheric Research, Wellington, 301 Evans Bay Parade, Greta Point, P.O. Box 14 901, Kilbirnie
GRAINZ	Geoscience Research and Investigations New Zealand, 62 Cashel Street, Apt. 5, Christchurch
CUC	Geology Department, Canterbury University, Christchurch, Private Bag, Christchurch

France

LMSE	Laboratoire de Modélisation de Climat et de l'Environnement, CFR, Avenue de la Terrasse, BP n°1, F-91198 Gif-s.-Yvette cedex
DGO	Département Géologie et Océanographie, U.M.R. EPOC 5805 - CNRS, Talence, Université de Bordeaux I, Avenue des Facultés, F-33405 Talence cedex
BBM	Laboratoire de Biologie et Biotechnologies Marines, Université de Caen Basse Normandie, F-14032 Caen cedex

Date	Time in	Site	Station	Instr.	Lat. °S	Long. °E	W.D. (m)	Recov.	Time in	Lat. °S	Long. °E
1998	UTC			Code			HS/PS		UTC		
Challenger Plateau											
17:10	15:35	1	001	PLN	42:17.29	170:00.11	0-200	+	15.35	42:17.29	170:00.11
17:10	17:00	1	002	EBS	42:17.99	170:00.00	1 NM	+	18.40	42:17.65	169:56.05
17:10	20:55	1	003	GC	42:17.74	169:52.66	958	7.70	21.20	42:17.74	169:52.66
17:10	22:03	1	004	MUC	42:17.28	168:52.48	953 (cable)	+	22:03	42:17.28	168:52.48
17:10	23:15	1	005	MUC	42:18.12	169:52.23	958/952 (cable)	+	23.15	42:18.12	169:52.23
17:10	23:30	1	006-A	HPN	42.18.00	169.50.00	0-10	+	23:30	42.18.00	169.50.00
18:10	00.30	1	006-B	SWS	42:17.69	169:50.69	0	+	00.30	42:17.69	169:50.69
18:10	0:55	1	007	CTD	42:17.71	169:50.65	970	+	0:55	42:17.71	169:50.65
18:10	11:33	2	008	PLN	43:26.12	167:51.73	0-200	+	11:33	43:26.12	167:51.73
18:10	13:00	2	009	PLN	43:26.12	167:51.73	0-200	+	13:00	43:26.12	167:51.73
18:10	14:38	2	010	CTD	43:26.56	167:51.27	1554 (max.)	+	14:38	43:26.56	167:51.27
18:10	15:30	2	011	GC	43:26.40	167:51.04	1556 (start)	8.92	15.30	43:26.40	167:51.04
18:10	17:39	2	012	EBS	43:25.15	167:50.15	1523-1526	+	19:43	43:22.78	167:46.65
18:10	22:28	2	013	BX	43:20.10	167:41.89	1547 (in)	0.22	22:48	43:20.10	167:41.89
20:10	5:01	2-3	XBT-1	XBT	48:00.32	167.26.06		+	5:01	48:00.32	167.26.06
21:10	3:00	2-3	Profile 1	Parasound	50:03.80	173:22.30		+	WP-1	50:03.80	173:22.30
East Campbell Plateau											
21:10	21:44	3	014	PLN	50:51.17	176:53.16	0-100	+	21:44	50:51.17	176:53.16
21:10	22:00	3	015	PLN	50:50.95	176:53.17	0-200	+	22:00	50:50.95	176:53.17
22:10	0:11	3	016	CTD	50:50.89	176:53.33	4535/4518	+	0:11	50:50.89	176:53.33
21:10	23:16	3	017	SWS	50:50.80	176:53.41	0	+	23:16	50:50.80	176:53.41
21/22:10	23:41	3	018	HPN	50:50.81	176:53.38	0-10	+	23:41	50:50.81	176:53.38
22:10	2:35	3	019	BX	50:51.08	176:53.20	4530/4516	0.38	2:35	50:51.08	176:53.20
22:10	5:42	3	020	GC-12	50:51.02	176:53.31	4529/4517	0.00	5:42	50:51.02	176:53.31
22:10	12:24	4	021	PLN	50:39.06	176:22.67	0-100	+	12:24	50:39.06	176:22.67
22:10	12:40	4	022	PLN	50:39.05	176:22.67	0-200	+	12:40	50:39.05	176:22.67
22:10	15:38	4	023	CTD	50:39.08	176:22.62	3456/3441	+	15:38	50:39.08	176:22.62
22:10	13:27	4	024	SWS	50:39.03	176:22.69	0	+	13:27	50:39.03	176:22.69
22:10	18:08	4	025	BX	50:39.04	176:22.69	3451/3436	0.19	18:08	50:39.04	176:22.69
23:10	1:21	5	026	PLN	50:19.92	175:35.01	0-100	+	1:21	50:19.92	175:35.01
23:10	1:38	5	027	PLN	50:19.82	175:34.99	0-200	+	1:38	50:19.82	175:34.99
23:10	2:46	5	028	CTD	50:19.81	175:34.83	1773 (HS)	+	2:46	50:19.81	175:34.83

Station	Time bot.	Lat. °S	Long. °E	Time out	Lat. °S	Long. °E	WD (bottom)
	UTC						
001				16.00			200
002	19:12:00 (end)	42:17.65	169:54.70	20.13	42:17.75	169:52.46	937-945
003	21:32	42:17.74	169:52.57	21:42	42:17.76	169:52.49	944
004	22:20			22.52	42:17.94	169:52.29	959
005	23:40	42:18.31	169:52.00	0:04			958
006-A							0-10
006-B							0
007							970 (max)
008				12:00	43:26.12	167:51.73	200-0
009				13:29	43:26.12	167:51.73	200-0
010							1554 (max.)
011	16:02	43:26.22	167:51.22				1546 (bottom)
012	20:09:00 (end)	43:21.47	167:44.66	21:46:00 (on deck)	43:20.32	167:42.40	1523-1526
013	23:00	43:20.02	167:41.56				1552 (bottom)
XBT-1				21.10.1998;	50:51.74	176:54.50	Profile
Profile 1	WP-2	50:09.30	175:08.60	WP-3 (21:10; 22:40)	50:53.87	176:59.86	Profile
014				21:55	50:50.35	176:53.17	0-100
015				22.25	50:50.77	176:53.22	0-200
016							4535
017							
018				01.01 (22.10.98)			0-10
019	04:03.40	50:51.12	176:53.18	5:25	50:51.02	176:53.32	4530/4516
020	07:04.03	50:51.02	176:53.26	8:10	50:50.91	176:53.20	4529/4517
021				12:36	50:39.05	176:22.67	0-100
022				13:02	50:59.00	176:22.67	0-200
023							3453
024							0
025	19:13	50:38.99	176:22.56	20:30	50:38.98	176:22.56	3452/3435
026				1:37	50:19.82	175:34.99	0-100
027				2:04	50:19.78	175:34.83	0-200
028							1573

Station	Samples to
001	De Deckker
002	De Deckker/Jellinek/Swanson
003	Findlay/vd Lingen/Nees
004	Core 1, 2, 7
005	Core 2 Schulz; Core 3-8 plan
006-A	Probert
006-B	De Deckker
007	Jurkschat/Neil/Müller/Probert/Willamowski
008	De Deckker
009	De Deckker
010	Jurkschat/Neil/Müller/Probert/Willamowski
011	Findlay/vd Lingen/Nees
012	Jellinek/Swanson (De Deckker)
013	Willamowski/Laurent/Findlay/Müller/Schulz/Altenbach/Nees/v.d.Lingen/Swanson/Jellinek/Howard
XBT-1	Neil
Profile 1	
014	De Deckker
015	De Deckker
016	Jurkschat/Neil/Müller/Probert/Willamowski
017	De Deckker
018	Probert
019	Elisa/Claire/Will H./Leanne A.
020	Banana
021	De Deckker
022	De Deckker
023	Jurkschat/Neil/Müller/Willamowski
024	De Deckker
025	Schulz/Laurent/Howard/Findlay/Leanne A./Neil/Altenbach/Jellinek/Jurkschat/Nees/Swanson/vdLingen
026	De Deckker
027	De Deckker
028	Jurkschat/Neil/Müller/Probert/Willamowski

Station	Remarks	
001	Local time: 04:35 (18:10)	
002		
003		
004	Core 4 empty; Pen.depth: 18 cm.	
005	Core 1 XXX; Pen.depth: 25 cm.	
006-A		
006-B	Local time: (18.10) 13:30; nannoplankton and isotopes	
007	No. bottles 24; Depth bottles (m): 10, 30, 50, 100, 200, 350, 500, 950	
008	EMPTY; Local time: (19:10) 00:33	
009	Local time: (19:10) 01:00	
010	No. bottles 19; Depth bottles (m): 10, 30, 50, 100, 200, 500, 1000, 1500	
011	Barrel: 12m; Max. Zug 5.5; Cablelength: 1520m	
012		
013	tension 3.9 t; WT 1530	
XBT-1	See list on stationsheet; 39 XBT drops	
Profile 1		
014	Local time: (22:10) 10:44 (in), 10:55 (out); without salpen	
015	Local time: (22:10) 11:00 (in), 11:25 (out); salpen	
016	No. bottles 21; Depth bottles (m): 10, 50, 100, 200, 500, 1000, 2000, 3000, 4500; winch problems	
017	Local time: (22:10) 12:16	
018		
019	Pinger 48 m; Zug 6.8 t; Box core and Thermometer	
020	Failure; Max. Zug 7.9; Cable 4495m	
021	Local time: 01:24 in, 01:36 out	
022	Local time: 01:40 in, 2:02 out	
023	No. bottles 19; Depth bottles (m): 10, 30, 50, 100, 200, 500, 1000, 2000, 3000, 3500; winch problems	
024	Local time: (23:10) 02:26; Nannoplankton: stable isotopes	
025	Cable 3408 m; Max. Tow (Max. Zug) 10.1 t; Pinger 48 m	
026	Local time: 14:21 in, 14:37 out	
027	Local time: 14:38 in, 15:04 out	
028	No. bottles 22; Depth bottles (m): 10, 30, 50, 100, 200, 500, 750, 1000, 1250, 1500	

Date	Time in	Site	Station	Instr.	Lat. °S	Long. °E	W.D. (m)	Recov.	Time in	Lat. °S	Long. °E
22:10	1:50	5	029	HPN	50:19.78	175:34.98	0-10	+	1:50	50:19.78	175:34.98
23:10	2:23	5	030	SWS	50:13.78	175:34.90	0	+	2:23	50:19.78	175:34.90
23:10	4:04	5	031	BX	50:19.82	175:34.85	1571/1568	0.22	4:04	50:19.82	175:34.85
23:10	5:35	5	032	GC-06	50:19.84	175:34.56	1574/1575	0.00	5:35	50:19.84	175:34.56
23:10	7:00	5	033	GC-06S	50:20.16	175:34.26	1577	0.00	7:00	50:20.16	175:34.26
23:10	10:00	6	034	PLN	50:13.89	175:18.62	0-100	+	10:00	50:13.89	175:18.62
23:10	11:04	6	035	CTD	50:13.42	175:18.98	1361	+			
23:10	10:45	6	036	SWS	50:13.34	175:18.92	0	+	10:45	50:13.34	175:18.92
23:10	12:10	6	037	BX	50:13.51	175:19.01	1362	0.19	12:10	50:13.51	175:19.01
23:10	13:26	6	038	GC-6	50:13.43	175:18.73	1359	4.07	13:26	50:13.43	175:18.73
23:10	18:30	7	039	PLN	50:07.85	174:41.27	0-100	+	18:30	50:07.85	174:41.27
23:10	18:53	7	040	PLN	50:07.98	174:41.61	0-200	+	18:53	50:07.98	174:41.61
23:10	19:56	7	041	CTD	50:07.93	174.07.60	960/957	+			
23:10	20:30	7	042	SWS	50:07.98	174:41.61	0	+	20:30	50:07.98	174:41.61
23:10	20:45	7	043	BX	50:07.86	174:41.31	956	0.23	20:45	50:07.86	174:41.31
23:10	21:41	7	044	GC-6	50:07.91	174:41.49	959	2.91	21:41	50:07.91	174:41.49
23/24:10	23:15	7	045	EBS	50:07.77	174:40.65	927/924	+	00:47 (start)	50:07.44	174:36.88
24:10	4:26	8	046	PLN	50:06.60	174:16.30	0-100	+	4:26	50:06.60	174:16.30
24:10	4:42	8	047	PLN	50:06.68	174:16.47	0-200	+	4:42	50:06.68	174:16.47
24:10	5:42	8	048	CTD	50:06.30	174:16.31	755/756	+			
24:10	5:26	8	049	SWS	50:06.36	174:16.35	0	+	5:26	50:06.36	174:16.35
24:10	6:26	8	050	BX	50:06.55	174:16.02	756/757	0.17	6:26	50:06.55	174:16.02
24:10	7:12	8	051	GC-6	50:06.88	174:15.57	760/760	2.90	7:12	50:06.88	174:15.57
24:10	12:09	9	052	CTD	50:09.91	173:21.97	561/562	+	12:09	50:09.91	173:21.97
24:10	13:00	9	053	SWS	50:09.98	173:22.02	0	+	13:00	50:09.98	173:22.02
24:10	13:46	9	054	BX	50:09.81	173:21.99	562	lost	13:46	50:09.81	173:21.99
24:10	14:21	9	055	GC-6	50:09.61	173:21.91	563	5.45	14:21	50:09.61	173:21.91
26:10	3:00	9-10	XBT-2	XBT	50:08.12	172:35.25		+	5:24	50:08.12	172:35.25
West Campbell Plateau											
26:10	14:59	10	056	SWS	53:20.00	169:14.94	0	+	14:59	53:20.00	169:14.94
26:10	15:11	10	057	PLN	53:20.01	169:15.02	0-100	+	15:11	53:20.01	169:15.02
26:10	15:26	10	058	PLN	53:20.04	169:15.02	0-200	+	15:26	53:20.04	169:15.02
26:10	16:19	10	059	CTD	53:20.13	169:14.97	603/604	+	16:19	53:20.13	169:14.97
26:10	16:59	10	060	BX	53:20.02	169:15.05	601	0.20	16:59	53:20.02	169:15.05

Station	Time bot.	Lat. °S	Long. °E	Time out	Lat. °S	Long. °E	WD (bottom)
029				2:50			0-10
030				2:23	50:19.78	175:34.90	0
031	4:33	50:19.80	175:34.82	5:03	50:19.80	175:34.63	1571
032	6:04	50:19.88	175:34.38	6:36	50:19.92	175:34.22	1575
033	07:29?	50:20.09	175:34.28	7:58	50:20.03	175:34.21	1574
034							0-100
035	11:04	50:13.42	175:18.98				1361
036				10:45	50:13.34	175:18.92	0
037	12:35	50:13.51	175:19.07	13:05	50:13.46	175:19.92	1364
038	13:48	50:13.39	175:18.48	14:11	50:13.38	175:18.25	1359
039				18:50	50:07.85	174:41.27	0-100
040				19:20	50:07.89	175:41.59	0-200
041	19:56	50:07.93	174:41.60				960/957
042				20:30	50:07.98	174:41.61	0
043	21:03	50:07.86	174:41.40	21:21	50:07.91	174.41.45	959
044	22:05	50:07.98	174:41.56	22:22	50:07.97	174:41.57	961
045	01:16:00 (end)	50:07.36	174:36.37	02:21:00 (deck)	50:07.11	174:33.58	935/928
046				4:40	50:06.68	174:16.47	0-100
047				5:06	50:06.42	174:16.58	0-200
048	5:42	50:06.30	174:16.31				755
049				5:26	50:06.36	174:16.35	0
050	6:40	50:06.62	174:15.89	6:59	50:06.73	174:15.94	756/757
051	7:32	50:06.81	174:15.58	7:45	50:06.84	174:15.48	758/759
052							561
053				13:00	50:09.98	173:22.02	0
054	13:57	50:09.73	173:21.97	14:10	50:09.66	173:21.96	562
055	14:35	50:09.54	173:21.88	14:45	50:09.48	173:21.84	563
XBT-2				01:52 (27:10)	53:12.62	169:22.90	
056				14:59	53:20.00	169:14.94	0
057				15:24	53:20.04	169:15.02	0-100
058				15:52	53:20.14	169:14.92	0-200
059	16:19	53:20.13	169:14.97				603
060	17:11	53:20.00	169:15.04	17:24	53:20.03	169:15.05	601

Station	Samples to
029	Probert
030	De Deckker
031	Schulz/Laurent/Howard/Findlay/Leanne A./slices every 5 cm.
032	EMPTY/WASHED OUT
033	EMPTY/WASHED OUT
034	De Deckker
035	Jurkschat/Neil/Müller/Probert/Willamowski
036	De Deckker
037	Howard/Leanna A./Findlay/Schulz/Alterbach/Jurkschat/Willamowski/Müller/Laurent
038	Findlay; see scheme
039	De Deckker
040	De Deckker
041	Jurkschat/Neil/Müller/Probert/Willamowski
042	De Deckker
043	Howard/Leanna A./Findlay/Schulz/Alterbach/Jurkschat/Willamowski/Müller/Laurent
044	Findlay; see scheme
045	Jellinek/Swanson
046	De Deckker
047	De Deckker
048	Jurkschat/Neil/Müller/Probert/Willamowski
049	De Deckker
050	Howard/Leanna A./Findlay/Schulz/Alterbach/Jurkschat/Willamowski/Müller/Laurent
051	
052	Jurkschat/Neil/Müller/Probert/Willamowski
053	De Deckker
054	
055	
XBT-2	Neil
056	De Deckker
057	De Deckker
058	De Deckker
059	Jurkschat/Neil/Müller/Willamowski
060	

Station	Remarks	
029		
030	Stable isotopes, nannoplankton	
031	Pinger 48 m; Pull 3.10; Temp 6.59 °C	
032	Cable length 1532; Max. pull 4.4 t	
033	Max Pull 4.2 t	
034	Net broken.	
035	No. bottles 19; Depth bottles (m): 10, 30, 50, 100, 200, 500, 750, 1000, 1300	
036	Local time: 23:43	
037	Max. pull: 3.2 t; Thermometer 6.824 °C	
038	Max. pull 6.1 t	
039	Local time: (24:10) 07:30 in, 07:50 out	
040	Local time: (24:10) 07:53 in, 08:20 out; Teared to pieces shortly before coming on board, sample saved	
041	No. bottles 17; Depth bottles (m): 10, 30, 50, 100, 200, 500, 750, 900, 960	
042	Local time: (24:10) 08:30	
043	Max. pull 2.4 t; Thermometer 5.88 °C	
044	Max. pull 4.3 t	
045	Depth 927-935	
046	Local time: 17:26 in, 17:40 out	
047	Local time: 17:42 in, 18:06 out	
048	No. bottles 15; Depth bottles (m): 10, 30, 50, 100, 200, 500, 750	
049	Local time: 18:26	
050	Max. pull 2.3 t; Temp. 6.8 °C	
051	Max. pull 3.8 t	
052	No. bottles 15; Depth bottles (m): 10, 30, 50, 100, 200, 350, 500, 561	
053	Local time: (25:10) 02:00; No plankton net at this station	
054	Max. pull 2.6 t, LOST DURING STORM	
055	Max. pull 3.3 t: HEAVILY MOVED IN LABORATORY	
XBT-2	See list on stationsheet; 14 XBT drops	
056	Local time: (27:10) 02:59	
057	Local time: (27:10) 03:11 in, 03:24 out	
058	Local time: (27:10) 03:26 in, 03:52 out	
059	No. bottles 24; Depth bottles (m): 10, 30, 50, 100, 200, 300, 400, 500, 580	
060	Max. pull 2.1 t	

Date	Time in	Site	Station	Instr.	Lat. °S	Long. °E	W.D. (m)	Recov.	Time in	Lat. °S	Long. °E
26:10	17:42	10	061	GC-6	53:20.00	169:14.96	602/610	2.25	17:42	53:20.00	169:14.96
26:10	18:48	10	062	EBS	53:19.85	169:14.81	628-636	+	20:01 (Start)	53:19.04	169:11.34
27:10	2:00	11	063	PLN	54:04.93	168:30.01	0-100	+	2:00	54:04.93	168:30.01
27:10	2:29	11	064	PLN	54:05.01	168:29.96	0-200	+	2:29	54:05.01	168:29.96
27:10	3:16	11	065	CTD	54:05.00	168:30.09	981/982	+			
27:10	2:50	11	066	HPN	54:05.03	168:30.07	0-10	+	2:50	54:05.03	168:30.07
27:10	3:10	11	067	SWS	54:05.31	168:30.00	0	+	3:10	54:05.31	168:30.00
27:10	4:07	11	068	BX	54:05.01	168:30.06	981	0.18	4:07	54:05.01	168:30.06
27:10	5:03	11	069	GC-6	54:04.99	168:30.09	981	0.00	5:03	54:04.99	168:30.09
27:10	5:59	11	070	GC-6	54:04.97	168:30.16	981	0.00	5:59	54:04.97	168:30.16
27:10	12:03	12	071	PLN	54:44.95	167:30.12	0-100	+	12:03	54:44.95	167:30.12
27:10	12:20	12	072	PLN	54:44.88	167:30.08	0-200	+	12:20	54:44.88	167:30.08
27:10	13:15	12	073	CTD	54:45.01	167:29.88	1108/1106	+			
27:10	12:55	12	074	SWS	54:44.95	167:30.04	0	+	12:55	54:44.95	167:30.04
27:10	13:58	12	075	BX	54:44.95	167:29.86	1109/1106	0.00	13:58	54:44.95	167:29.86
27:10	14:46	12	076	BX	54:44.98	167:29.95	1108/1105	0.00	14:46	54:44.98	167:29.95
27:10	15:43	12	077	GC-6	54:44.97	167:29.97	1109/1107	0.00	15:43	54:44.97	167:29.97
27:10	21:00	13	078	PLN	55:19.98	166:39.96	0-100	+	21:00	55:19.98	166:39.96
27:10	21:20	13	079	PLN	55:19.96	166:40.04	0-200	+	21:20	55:19.96	166:40.04
27:10	22:37	13	080	CTD	55:20.01	166.39.98	1679	+			
27:10	22:00	13	081	SWS	55:20.00	166:40.05	0	+	22:00	55:20.00	166:40.05
27:10	23:50	13	082	BX	55:20.07	166:39.96	1681	0.18	23:50	55:20.07	166:39.96
28:10	1:04	13	083	GC-6	55:20.07	166:40.01	1685	0.00	1:04	55:20.07	166:40.01
28:10	4:58	14	084	PLN	55:29.98	165:52.08	0-100	+	4:58	55:29.98	165:52.08
28:10	5:17	14	085	PLN	55:30.08	165:52.12	0-200	+	5:17	55:30.08	165:52.12
28:10	6:36	14	086	CTD	55:30.06	165:52.19	2073	+	6:36	55:30.06	165:52.19
28:10	5:50	14	087	SWS	55:33.00	165:52.05	0	+	5:50	55:33.00	165:52.05
28:10	8:13	14	088	BX	55:30.11	165:52.18	2073	0.00	8:13	55:30.11	165:52.18
28:10	11:59	15	089	PLN	55:50.07	165:30.35	0-100	+	11:59	55:50.07	165:30.35
28:10	12:10	15	090	PLN	55:50.23	165:30.55	0-200	+	12:10	55:50.23	165:30.55
28:10	14:17	15	091	CTD	55:50.24	165:30.21	2998	+			
28:10	14:00	15	092	SWS	55:50.15	165:30.21	0	+	14:00	55:50.15	165:30.21
28:10	16:15	15	093	BX	55:49.99	165:30.06	2964	0:00	16:15	55:49.99	165:30.06
29:10	4:16	16	094	PLN	55:42.12	165:07.96	0-100	+	4:14	55:42.12	165:07.96

Station	Time bot.	Lat. °S	Long. °E	Time out	Lat. °S	Long. °E	WD (bottom)
061	17:58	53:20.02	169:14.96	18:10	53:19.99	169:14.99	602
062	20:33 (end)	53:18.70	169:09.83	21:10	53:18.31	169:08.24	628-636
063				2:10	54:05.01	168:29.96	0-100
064				2:46	54:05.03	168:30.00	0-200
065	3:16	54:05.00	168:30.09				982
066				3:35	54:05.03	168:30.07	0-10
067				3:10	54:05.31	168:30.00	0
068	04:xx	54:05.03	168:30.03	4:45	54:05.06	168:30.05	980
069	5:20	54:05.05	168:30.04	5:36	54:05.04	168:30.07	981
070	6:20	54:05.06	168:30.09	6:34	54:05.07	168:30.03	981
071				12:15	54:44.88	167:30.08	0-100
072				12:45	54:44.92	167:30.00	0-200
073	13:15	54:45.01	167:29.88				1110
074				12:55	54:44.95	167:30.04	0
075	14:18	54:44.97	167:29.94	14:35	54:44.04	167:29.94	1108
076	15:08	54:45.00	167:29.92	15:26	54:45.00	167:29.92	1108
077	16:01	54:44.99	167:29.92	16:17	54:44.98	167:29.84	1111/1107
078				21:15	55:19.96	166:39.96	0-100
079				21:45	55:20.00	166:40.00	0-200
080	22:37	55:20.01	166:39.98				1679
081				22:00	55:20.00	166:40.05	0
082	0:22	55:20.08	166:40.07	0:49	55:20.05	166:40.04	1685
083	1:31	55:20.11	166:39.98	1:55	55:20.17	166:39.89	1688
084				5:15	55:30.08	165:52.13	0-100
085				5:40	55:30.03	165:52.12	0-200
086	6:36	55:30.06	165:52.19				2073
087				5:50	55:33.00	165:52.05	0
088	8:54	55:30.09	165:52.23				2074
089				12:15	55:50.23	165:30.55	0-100
090				12:42	55:50.27	165:30.69	0-200
091	14:17	55:50.24	165:30.21				2998
092				14:00	55:50.15	165:30.21	0
093	17:10	55:50.05	165:30.37	18:03	55:50.24	165:30.78	2964
094				4:30	55:45.62	165:08.24	0-100

Station	Samples to
061	
062	Jellinek/Swanson
063	De Deckker
064	De Deckker
065	Jurkschat/Neil/Müller/Probert/Willamowski
066	Probert
067	De Deckker
068	
069	
070	
071	De Deckker
072	De Deckker
073	Jurkschat/Neil/Müller/Willamowski
074	De Deckker
075	
076	
077	
078	De Deckker
079	De Deckker
080	Jurkschat/Neil/Müller/Willamowski
081	De Deckker
082	
083	
084	De Deckker
085	De Deckker
086	Jurkschat/Neil/Müller/Willamowski
087	De Deckker
088	
089	De Deckker
090	De Deckker
091	Jurkschat/Neil/Müller/Sturm/Willamowski
092	De Deckker
093	
094	De Deckker

Station	Remarks	
061	Max. pull 3.0 t	
062	1 Nautical mile	
063	Local time: 14:00-14:20	
064	Local time: 14:25-14:46	
065	No. bottles 17; Depth bottles (m): 10, 30, 50, 100, 200, 500, 750, 900	
066		
067	Local time 15:10; Nannoplankton & stab. isotopen	
068	Max. pull 3.1 t; Cable 976	
069	Max. pull 3.1 t	
070	Max. pull 3.2 t	
071	Local time 00:03-00:15 (28.10.98); salpen	
072	Local time 00:20-00:45 (28.10.98); salpen	
073	No. bottles 17; Depth bottles (m): 10, 30, 50, 100, 200, 500, 750, 950	
074	Local time 00:55 (28.10.98)	
075	Max. pull 2.4 t	
076	Max. pull 2.1 t	
077	Max. pull 3.1 t	
078	Local time 09:00-09:15 (28.10.98)	
079	Local time 09:20-09:45 (28.10.98)	
080	No. bottles 19; Depth bottles (m): 10, 30, 50, 100, 200, 500, 1000, 1500, 1650	
081	Local time 10:00	
082	Max. pull 3.4 t	
083	Max. pull 4.0 t	
084	Local time 16:58-17:15	
085	Local time 17:17-17:40; salpen	
086	No. bottles 19; Depth bottles (m): 10, 30, 50, 100, 200, 500, 1000, 1500, 2000	
087	Local time 17:50	
088	Max. pull 3.4 t; Temp. 2.316 °C	
089	Local time 23:59-00:15 (29.10.98)	
090	Local time 00:16-00:42 (29.10.98)	
091	No. bottles 21; Depth bottles (m): 10, 50, 100, 200, 500, 1000, 1500, 2000, 2500, 2900	
092	Local time 02:00 (29.10.98)	
093	Cable length 2935; Max. pull 4.5 t; Pinger 48 m; Cobble catch	
094	Local time 16:16-16:30	

Date	Time in	Site	Station	Instr.	Lat. °S	Long. °E	W.D. (m)	Recov.	Time in	Lat. °S	Long. °E
29:10	4:31	16	095	PLN	55:45.62	165:08.24	0-200	+	4:31	55:45.62	165:08.24
29:10	7:37	16	096	CTD	55:46.71	165:09.28	4156	+			
29:10	5:23	16	097	SWS	55:45.04	165:07.92	0	+	5:23	55:45.04	165:07.92
29:10	11:10	16	098	BX	55:43.89	165:06.54	4163/4164	0.335	11:10	55:43.89	165:06.54
29:10	14:15	16	099	GC-12	55:44.00	165:06.75	4182/4176	0.00	14:15	55:44.00	165:06.75
Emerald Basin											
30:10	7:18	17	100	GC-12	56:27.52	162:36.18	5009	6.26	7:18	56:27.52	162:36.18
30:10	10:35	17	101	BX	56:27.80	162:36.39	5005	0.00	10:35	56:27.80	162:36.39
30:10	17:00	18	102	CTD	56:28.88	162:15.47	4253/4249	+			
30:10	15.45	18	103	SWS	56:28.94	162:16.73	0	+	15:45	56:28.94	162:16.73
31:10	5:13	19	104	CTD	56:45.13	159:34.51	3988	+			
31:10	04.00	19	105	SWS	56:45.02	159:34.86	0	+	4:00	56:45.02	159:34.86
31:10	7:45	19	106	PLN	56:45.26	159:33.79	0-100	+	7:45	56:45.26	159:33.79
31:10	8:00	19	107	PLN	56:45.42	159:33.48	0-200	+	8:00	56:45.42	159:33.48
31:10	09.00	19	108	PCB	56:45.88	159:32.99	3974	+	9:00	56:65.88	159:32.99
31:10	10:11	19	109	SWS	56:45.94	159:32.84	0	+	10:11	56:45.94	159:32.84
31:10	19:54	20	110	BX	56:40.87	160:14.86	3907	0.335	19:54	56:40.87	160:14.86
31:10	22:46	20	111	GC-12	56:40.86	160:14.49	3912	9.61	22:46	56:40.86	160:14.49
01:11	7:25	21	112	PLN	55:40.04	159:25.22	0-100	+	7:25	55:40.04	159:25.22
01:11	7:42	21	113	PLN	55:39.99	159:25.25	0-200	+	7:42	55:39.99	159:25.25
01:11	-	21	114	CTD			-	-			
01:11	8:30	21	115	SWS	55:39.99	159:25.10	0	+	8:30	55:39.99	159:25.10
01:11	10:05	21	116	BX	55:40.03	159:25.00	4462/4446	0.36	10:05	55:40.03	159:25.00
01:11	13:01	21	117	GC-12	55:40.00	159:25.06	4460	10.69	13:01	55:40.00	159:25.06
South Tasman Rise											
03:11	8:00	22	118	CTD	52:48.80	150:36.74	3873	+			
03:11	7:10	22	119	SWS	52:48.80	150:35.68	0	+	7:10	52:48.80	150:35.68
03:11	9:59	22	120	PLN	52:48.85	150:35.76	0-100	+	9:59	52:48.85	150:35.76
03:11	10:17	22	121	PLN	52:48.89	150:35.83	0-200	+	10:17	52:48.89	150:35.83
03:11	12:01	22	122	PCB	52:48.92	150:35.84	3807	+	12:01	52:48.92	150:35.84
03:11	22:29	23	123	BX	52:59.89	151:08.23	4196/4184	0.40	22:29	52:59.89	151:08.23
04:11	1:27	23	124	GC-12	52:59.77	151:08.14	4199/4189	7.77	1:27	52:59.77	151:08.14
04:11	12:01	24	125	PLN	51:27.35	150:56.27	0-100	+	12:01	51:27.35	150:56.27
04:11	12:21	24	126	PLN	51:27.18	150:56.09	0-200	+	12:21	51:27.18	150:56.09

Station	Time bot.	Lat. °S	Long. °E	Time out	Lat. °S	Long. °E	WD (bottom)
095				4:57	55:45.97	165:08.65	0-200
096	7:37	55:46.71	165:09.28				4156
097				5:23	55:45.04	165:07.92	0
098	12:42	55:44.94	165:07.94	13:46	55:45.45	165:08.62	4138/4131
099	15:26	55:44.95	165:07.75	16:15	55:45.48	165:08.19	4142/4139
100	8:43	56:27.23	162:35.09	10:00	56:27.40	162:34.57	5010/4996
101	12:xx	56:27.37	162:36.20	13:40	56:27.65	162:36.21	5009
102	17:00	56:28.88	162:15.47				4253
103				15:45	56:28.94	162:16.73	0
104	5:13	56:45.13	159:34.51				3996
105				4:00	56:45.02	159:34.86	0
106				8:00	56:45.42	159:33.48	0-100
107				8:30	56:45.56	159:33.42	0-200
108	10:05	56:45.17	159:32.86	04:25 (01.11)	56:47.32	159:29.00	3701
109				10:11	56:45.94	159:32.84	0
110	21:16	56:40.65	160:14.49	22:24	56:40.81	160:14.44	3909/3893
111	23:50	56:40.04	160:14.80	0:45	56:41.21	160:15.03	3914
112				7:40	55:39.95	159:25.25	0-100
113				8:15	55:40.02	159:25.31	0-200
114							-
115				8:30	55:39.99	159:25.10	0
116	11:32	55:39.98	159:25.01	12:48	55:40.00	159:25.04	4467
117	14:20	55:40.00	159:25.06	15:29	55:40.03	159:25.07	4400
118	8:00	52:48.80	150:36.74				3873
119				7:10	52:48.80	150:35.68	0
120				10:15	52:48.83	150:35.83	0-100
121				10:47	52:48.94	150:35.91	0-200
122	13:20	52:48.78	150:36.29	19:23	52:48.87	150:35.82	3807
123	23:49	53:00.91	151:08.83	00:58 (04:11)	53:00.92	151:09.09	4146
124	2:36	52:59.71	151:08.19	3:38	52:59.69	151:08.21	4199/4189
125				12:20	51:27.18	150:56.09	0-100
126				12:47	51:27.06	150:55.91	0-200

Station	Samples to
095	De Deckker
096	Jurkschat/Neil/Müller/Sturm/Willamowski
097	De Deckker
098	
099	
100	
101	
102	Jurkschat/Neil/Müller/Probert/Sturm/Willamowski
103	De Deckker
104	Jurkschat/Neil/Müller/Probert/Sturm/Willamowski
105	De Deckker
106	De Deckker
107	De Deckker
108	Schulz-Büll
109	De Deckker
110	
111	
112	De Deckker
113	De Deckker
114	
115	De Deckker
116	
117	
118	Jurkschat/Neil/Müller/Sturm/Willamowski
119	De Deckker
120	De Deckker
121	De Deckker
122	Schülz-Büll
123	
124	
125	De Deckker
126	De Deckker

Station	Remarks	
095	Local time 16:31-16:57	
096	No. bottles 21; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 2000, 3000, 4000	
097	Local time 17:23	
098	Max. pull 5.8 t; Temp. 1.047 °C; Pinger 48 m; Cable length 4175m	
099	Failure; Max. pull 6.1 t; Cable length 4135m	
100	Max. pull 8.0 t; Cable length 4990m	
101	Max. pull 6.5 t; Temp. 0.936 °C; Pinger 48 m; Cable length 5000m	
102	No. bottles 24; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4200	
103		
104	No. bottles 24; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000, 3500, 3900	
105		
106		
107		
108	Pumps at 100, 700, 3000, 3020; in lab 17:20, 56:47.68 S, 159:28.89 E	
109		
110	Max. pull 5.6 t; Temp. 0.978 °C; Pinger 48 m; Cable length 3845m?	
111	Max. pull 7.2 t; Cable length 3845m?	
112		
113		
114	BURN OUT	
115		
116	Max. pull 7.3 t; Temp. 0.739 °C; Pinger 48 m; Cable length 4417m	
117	Max. pull 7.7 t; Cable length 4400m	
118	No. bottles 24; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000, 3800	
119		
120	Salps	
121		
122	On deck: 07:30 ship-time; Depth pumps 100, 1000, 3000, 3020	
123	Max. pull 5.9 t; Temp. 4.475 °C; Pinger 48 m; Cable length 4146m	
124	Max. pull 7.8 t; Cable length 4141m	
125	Local time 23:01 (in), 23:20 (out); without salpen	
126	Local time 23:21 (in), 23:47 (out); salpen	

Date	Time in	Site	Station	Instr.	Lat. °S	Long. °E	W.D. (m)	Recov.	Time in	Lat. °S	Long. °E
04:11	14:10	24	127	CTD	51:27.08	150:55.79	4033/4022	+			
04:11	13:05	24	128	SWS	51:27.03	150:55.84	0	+	13:05	51:27.03	150:55.84
04:11	16:18	24	129	BX	51:27.28	150:56.40	4037/4024	0.00	16:18	51:27.28	150:56.40
05:11	0:50	25	130	PLN	50:20.00	150:20.00	0-100	+	0:50	50:20.00	150:20.00
05:11	1:03	25	131	PLN	50:19.99	150:20.15	0-200	+	1:03	50:19.99	150:20.15
05:11	3:36	25	132	CTD	50:20.02	150:20.10	3385	+			
05:11	1:45	25	133	SWS	50:20.00	150:20.14	0	+	1:45	50:20.00	150:20.14
05:11	11:26	26	134	PLN	49:12.90	151:06.07	0-100	+	11:26	49:12.90	151:06.07
05:11	11:42	26	135	PLN	49:12.94	151:06.15	0-200	+	11:42	49:12.94	151:06.15
05:11	13:21	26	136	CTD	49.13.26	151:05.99	3028	+			
05:11	13:57	26	137	SWS	49:13.18	151:06.00	0	+	13:57	49:13.18	151:06.00
05:11	15:52	26	138	BX	49:13.06	151:05.77	3022	0.22	15:52	49:13.06	151:05.77
05:11	22:13	27	139	BX	49:10.75	150:10.29	1638/1631	-	22:13	49:10.75	150:10.29
05:11	23:38	28	140	BX	49:10.84	150:10.13	1636/1632	0.27	23:38	49:10.84	150:10.13
06:11	2:41	29	141	BX	49:08.34	149:54.98	1690/1688	0.17	2:41	49:08.34	149:54.98
06:11		ODP	Profile	STR02A	48:30.00	149:06.70	2155	+			
06:11	16:35	30	142	PLN	48:29.97	149:06.76	0-100	+	16:35	48:29.97	149:06.76
06:11	16:50	30	143	PLN	48:30.08	149:06.83	0-200	+	16:50	48:30.08	149:06.83
06:11	18:02	30	144	CTD	48:29.99	149:06.67	2178	+			
06:11	17:30	30	145	SWS	48:29.99	149:06.70	0	+	17:30	48:29.99	149:06.70
06:11	19:17	30	146	BX	48:30.01	149:06.71	2177/2173	--	19:17	48:30.01	149:06.71
06:11	20:51	30	147	BX	48:29.99	149:06.75	2177/2171	0.18	20:51	48:29.99	149:06.75
07:11	8:25	31	148	PLN	47:45.85	148:23.82	0-100	+	8:25	47:45.85	148:23.82
07:11	8:41	31	149	PLN	47:45.75	149:23.83	0-100	+	8:41	47:45.75	149:23.83
07:11	8:57	31	150	PLN	47:45.58	149:23.85	0-200	+	8:57	47:45.58	149:23.85
07:11	10:16	31	151	CTD	47:45.25	149:23.01	1842	+			
07:11	9:45	31	152	SWS			0	+	9:45	47:45.54	149:23.77
07:11	11:41	31	153	BX	47:46.85	149:23.73	1874/1850	0.105	11:41	47:46.85	149:23.73
07:11	13:34	31	154	GC-3	47:46.28	149:23.72	1839/1835	0.00	13:34	47:46.28	149:23.72
08:11	8:19	32	155	GC-12	47:00.09	149:31.30	3208/3204	7.56	8:19	47:00.09	149:31.30
08:11	10:30	32	156	BX	47:00.28	149:30.93	3208/3202	0.00	10:30	47:00.28	149:30.93
08:11	16:06	33	157	PLN	46:33.12	149:05.14	0-100	+	16:06	46:33.12	149:05.14
08:11	16:23	33	158	PLN	46:33.10	149:05.16	0-200	+	16:23	46:33.10	149:05.16

Station	Time bot.	Lat. °S	Long. °E	Time out	Lat. °S	Long. °E	WD (bottom)
127	14:10	51:27.08	150:55.79				4035
128				13:05	51:27.03	150:55.84	0
129	17:25	51:27.29	150:56.43	18:40	51:27.24	150:56.25	4035/4023
130				1:00	50:19.99	150:20.15	0-100
131				1:30	50:20.09	150:20.14	0-200
132	3:36	50:20.02	150:20.10				3385
133				1:45	50:20.00	150:20.14	0
134				11:40	49:12.94	151:06.05	0-100
135							0-200
136	13:21	49.13.26	151:05.99				3028
137				13:57	49:13.18	151:06.00	0
138	16:46	49:13.07	151:05.73	17:40	49:13.02	151:05.84	3020/3018
139	22:56	49:10.78	150:10.26	23:24	49:10.80	150:10.30	1636/1632
140	0:12	49:10.83	150:10.10	0:40	49:10.88	150:10.10	1634/1632
141	3:14	49:08.33	149:54.96	3:50	49:08.32	149:55.00	1660
Profile							
142				16:48	48:30.08	149:06.83	0-100
143				17:15	48:30.13	149:06.90	0-200
144	18:02	48:29.99	149:06.67				2178
145				17:30	48:29.99	149:06.70	0
146	20:02	48:30.98	149::06.72	20:40	48:30.01	149:06.71	2149
147	21:36	48:30.13	149:06.77	22:11	48:30.19	149:06.84	2146
148				8:40	47:45.75	148:23.83	0-100
149							0-100
150				9:21	47:45.56	149:23.77	0-200
151	10:16	47:45.25	149:23.01				1842
152				9:45	47:45.54	149:23.77	0
153	12:28	47:46.32	149:73.84	12:59	47:46.27	149:23.73	1841/1842
154	14:07	47:46.27	149:23.73	14:33	47:46.20	149:23.84	1840/1834
155	9:12	47:00.17	149:31.06	9:59	47:00.30	149:31.03	3208/3205
156	10:30	47:00.18	149:30.63	12:25	47:00.00	149:30.54	3211/3206
157				16:20	46:33.10	149:05.16	0-100
158				16:41	46:33.14	149:05.14	0-200

Station	Samples to
127	Jurkschat/Neil/Müller/Sturm/Willamowski
128	De Deckker
129	
130	De Deckker
131	De Deckker
132	Jurkschat/Neil/Müller/Sturm/Willamowski
133	De Deckker
134	De Deckker
135	De Deckker
136	Jurkschat/Neil/Müller/Sturm/Willamowski
137	De Deckker
138	
139	
140	
141	
Profile	
142	De Deckker
143	De Deckker
144	Jurkschat/Neil/Müller/Probert/Sturm/Willamowski
145	De Deckker
146	
147	
148	De Deckker
149	De Deckker
150	De Deckker
151	Jurkschat/Neil/Müller/Probert/Sturm/Willamowski
152	De Deckker
153	
154	
155	
156	
157	De Deckker
158	De Deckker

Station	Remarks	
127	No. bottles 24; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000, 4000	
128	Local time: 00:05 (05:11)	
129	Max. pull 5.4 t; Temp. 0.906 °C; Pinger 48 m; Cable length 3983m	
130	Local time 12:50 (in), 13:00 (out); without salpen	
131	Local time 13:03 (in), 13:30 (out); salpen	
132	No. bottles 23; Depth bottles (m): 10, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000, 3300	
133	Local time: 13:45	
134	Local time 22:26 (in), 22:40 (out); salpen	
135	Local time 22:42 (in), 22:30 (out)	
136	No. bottles 23; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000	
137	Local time: 00:57 (06:11)	
138	Max. pull 4.9 t; Temp. 1.671 °C; Cable length 2988m	
139	Max. pull 2.8 t; Temp. 2.645 °C; Cable length 1612m	
140	Max. pull 2.8 t; Temp. 2.662 °C; Cable length 1609m	
141	Max. pull 3.2 t; Cable length 1660m	
Profile	Waypoints ODP Site survey	
142	Local time (07:11) 03:35 (in), 03:48 (out); salpen	
143	Local time (07:11) 03:50 (in), 04:15 (out); salpen	
144	No. bottles 19; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2100	
145	Local time: 04:30 (07:11)	
146	Failure; Max. pull 3.4 t; Cable length 2149m	
147	Max. pull 3.5 t; Cable length 2146m	
148	Local time: 19:25 (in), 19:40 (out)	
149	Local time: 19:41 (in), salps	
150	Local time: 19:57 (in), 20:21 (out); salpen	
151	No. bottles 19; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 1800	
152	Local time: 20:45	
153	Max. pull 3.1 t; Cable length 1817m	
154	Max. pull 4.0 t; Cable length 1811m	
155	Max. pull 6.7 t; Cable length 3170m	
156	Max. pull 4.8 t; Cable length 3178m	
157	Local time: (09:11) 03:06 (in), 03:20 (out)	
158	Local time: (09:11) 03:23 (in), 03:41 (out)	

Date	Time in	Site	Station	Instr.	Lat. °S	Long. °E	W.D. (m)	Recov.	Time in	Lat. °S	Long. °E
08:11	18:10	33	159	CTD	46:33.18	149:04.98	3682	+			
08:11	17:05	33	160	SWS	46:33.16	149:05.01	0	+	17:05	46:33.16	149:05.01
08:11	20:20	33	161	BX	46:33.18	149:04.96	3685	0.38	20:20	46:33.18	149:04.96
08/09:11	23:06	33	162	GC-12	46:33.20	149:05.01	3682/3671	8.80	23:06	46:33.20	149:05.01
09:11	11:40	34	163	GC-12	45:56.88	147:30.85	3236/3238	8.38	11:40	45:56.88	147:30.85
09:11	20:36	35	164	GC-12	45:18.55	147:55.24	4068	9.78	20:36	45:18.55	147:55.24
09/10:11	23:20	35	165	BX	45:18.26	147:55.13	4067/4054	0.46	23:20	45:18.26	147:55.13
10:11	8:10	36	166	GC-12	44:38.48	148:32.06	3990/3979	--	8:10	44:38.48	148:32.06
10/11:11	11:00	ODP	Profile (SET01A)	WP1	45:18.50	147:55.00		+			
10:11	17:00	37	167	CTD	43:51.83	149:45.15	2869/2867	+			
10/11:11		ODP	Profile	WP14	44:04.00	149:46.00		+			

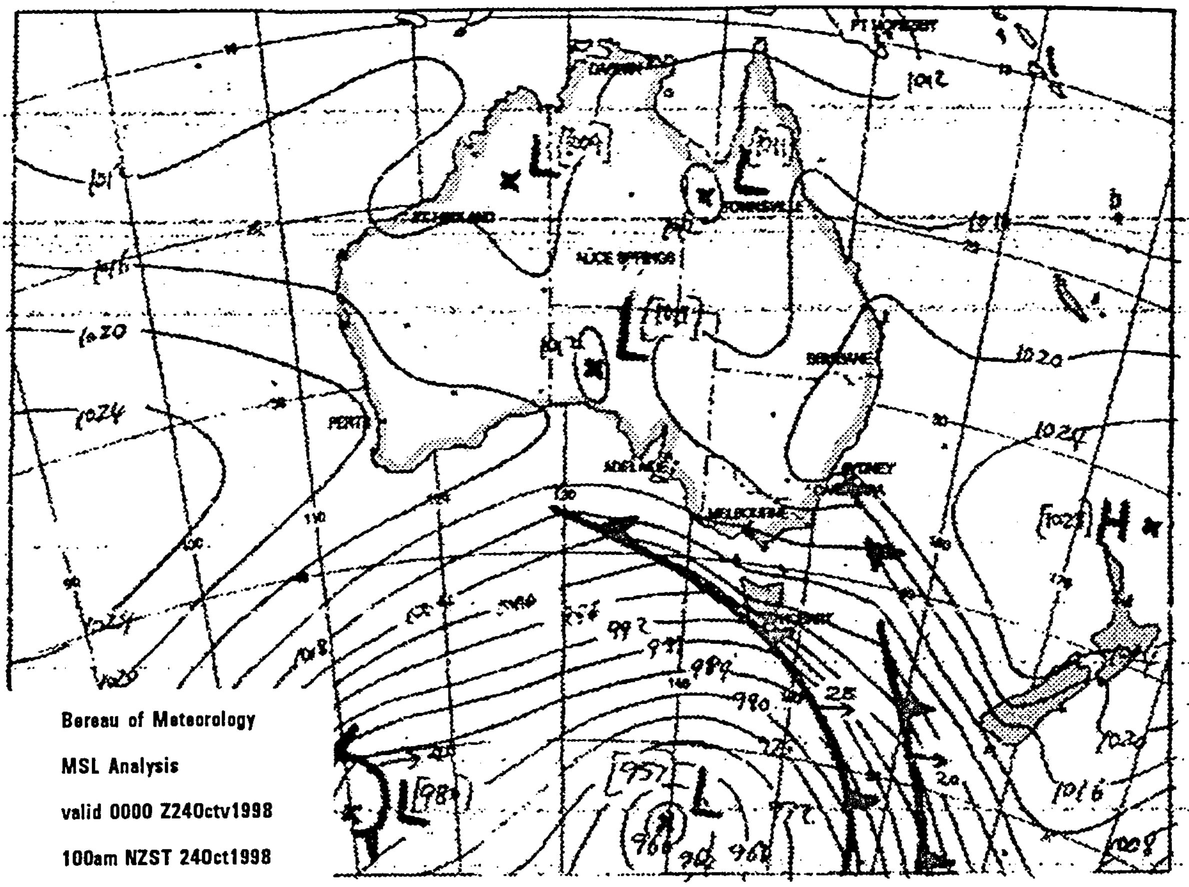
Abbreviations

BX	Box core
CTD	CTD
EBS	Epi-benthos slide
HPN	Hand plankton net
GC-6	Gravity core 6m
GC-6s	Gravity core 6m with special catcher
GC-12	Gravity core 12 m
PLN	Plankton net
SWS	Surface water sample
XBT	Expandable bathythermograph

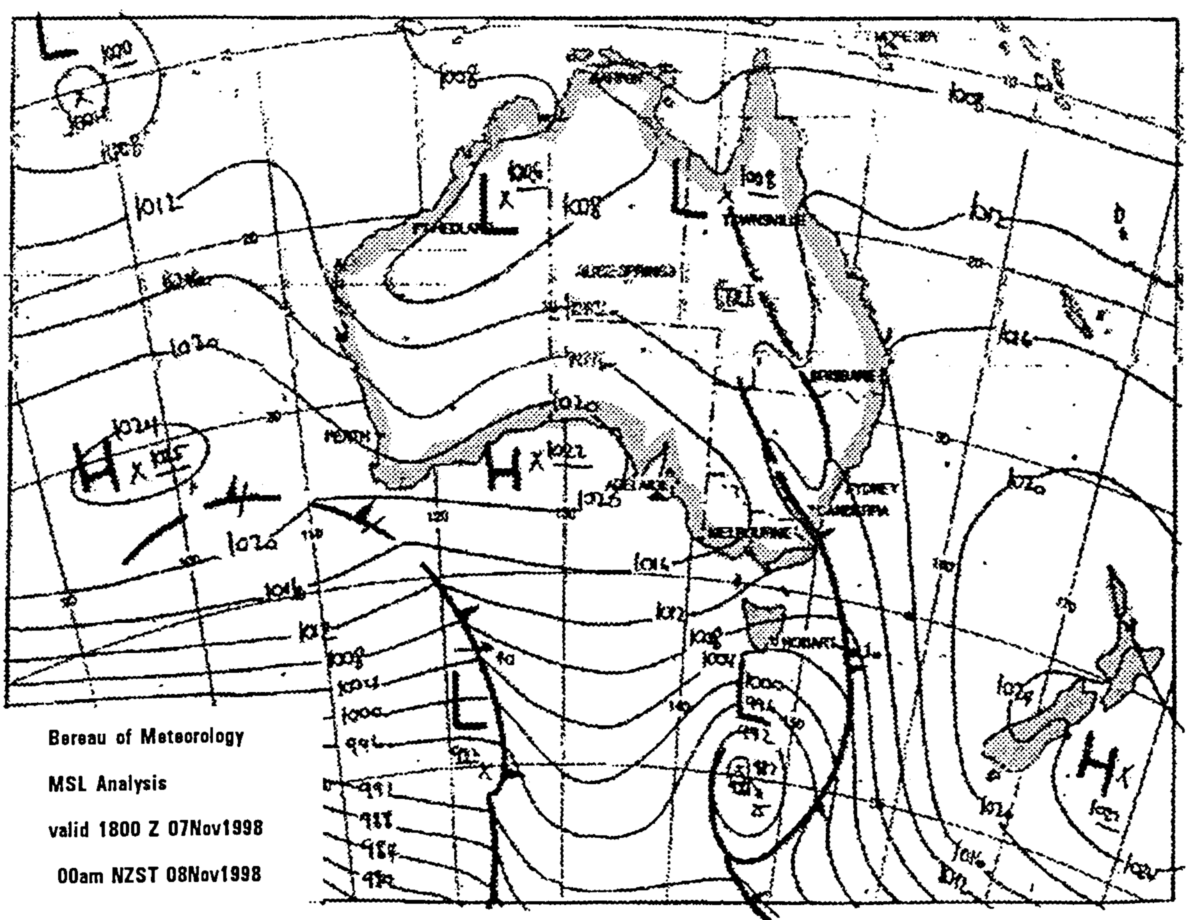
Station	Time bot.	Lat. °S	Long. °E	Time out	Lat. °S	Long. °E	WD (bottom)
159	18:10	46:33.18	149:04.98				3682
160				17:05	46:33.16	149:05.01	0
161	21:31	46:33.13	149:04.88	22.32	46:33.20	149:04.88	3685
162	0:10	46:33.19	149:05.08	1:02	46:33.13	149:04.91	3682/3671
163	12:35	45:56.66	147:30.09	13:24	45:56.43	147:29.25	3236/3238
164	21:44	45:18.78	147:55.35	22:42	45:19.15	147:55.77	4065/4055
165	0:41	45:17.84	147:55.13	1:48	45:17.96	147:56.59	4070/4055
166	9:24	44:38.42	148:31.87	10:20	44:38.56	148:31.58	3990/3979
Profile (SET01A)							
167	17:00	43:51.83	149:45.15				0-200
Profile							

Station	Samples to
159	Jurkschat/Neil/Müller/Probert/Sturm/Willamowski
160	De Deckker
161	
162	
163	
164	
165	
166	
Profile (SET01A)	
167	Probert
Profile	

Station	Remarks	
159	No. bottles 24; Depth bottles (m): 10, 30, 50,100, 200, 500, 1000, 1500, 2000, 2500, 3000, 3650	
160	Local time: 04:05	
161	Max. pull 7.4 t	
162	Max. pull 7.7 t; Cable length 3655m	
163	Max. pull 6.1 t; Cable length 3214m	
164	Max. pull 7.2 t; Cable length 4042m	
165	Max. pull 6.9 t; Cable length 4049m	
166	Max. pull 5.8 t; Cable length 3953m	
Profile (SET01A)	Waypoints ODP Site survey	
167	No. bottles 24; Depth bottles (m): 10, 50,100, 200	
Profile	Waypoints ODP Site survey	



Meteorologigal situation on Oct. 24th 1998. Map showing Low Pressure Field shortly before reaching FS Sonne



Meteorologigal situation on Nov. 8th 7th 1998 (UTC). Map showing Low Pressure Field close to the position of FS Sonne

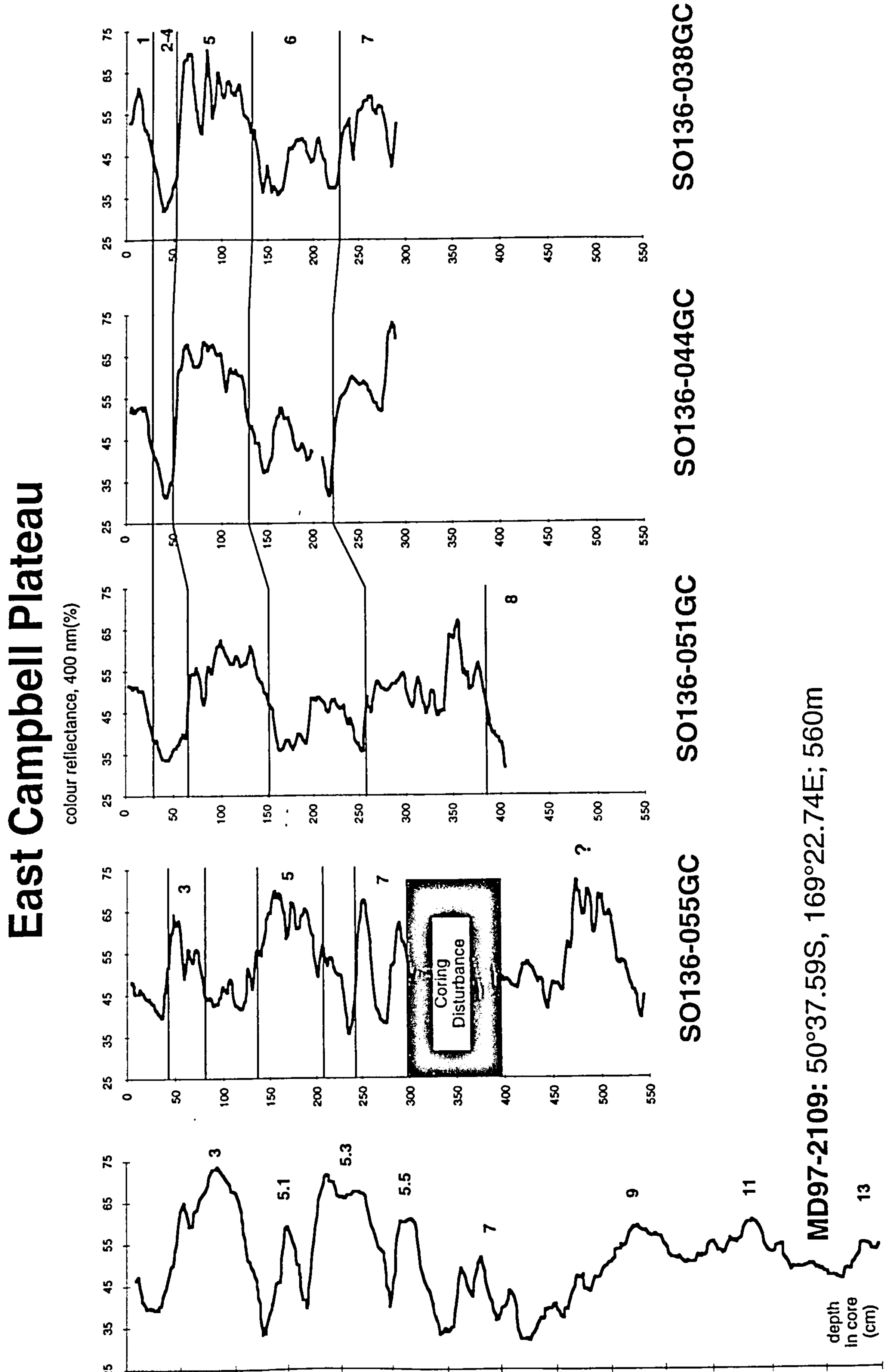
Planktic foraminiferal counts on sediment surface samples

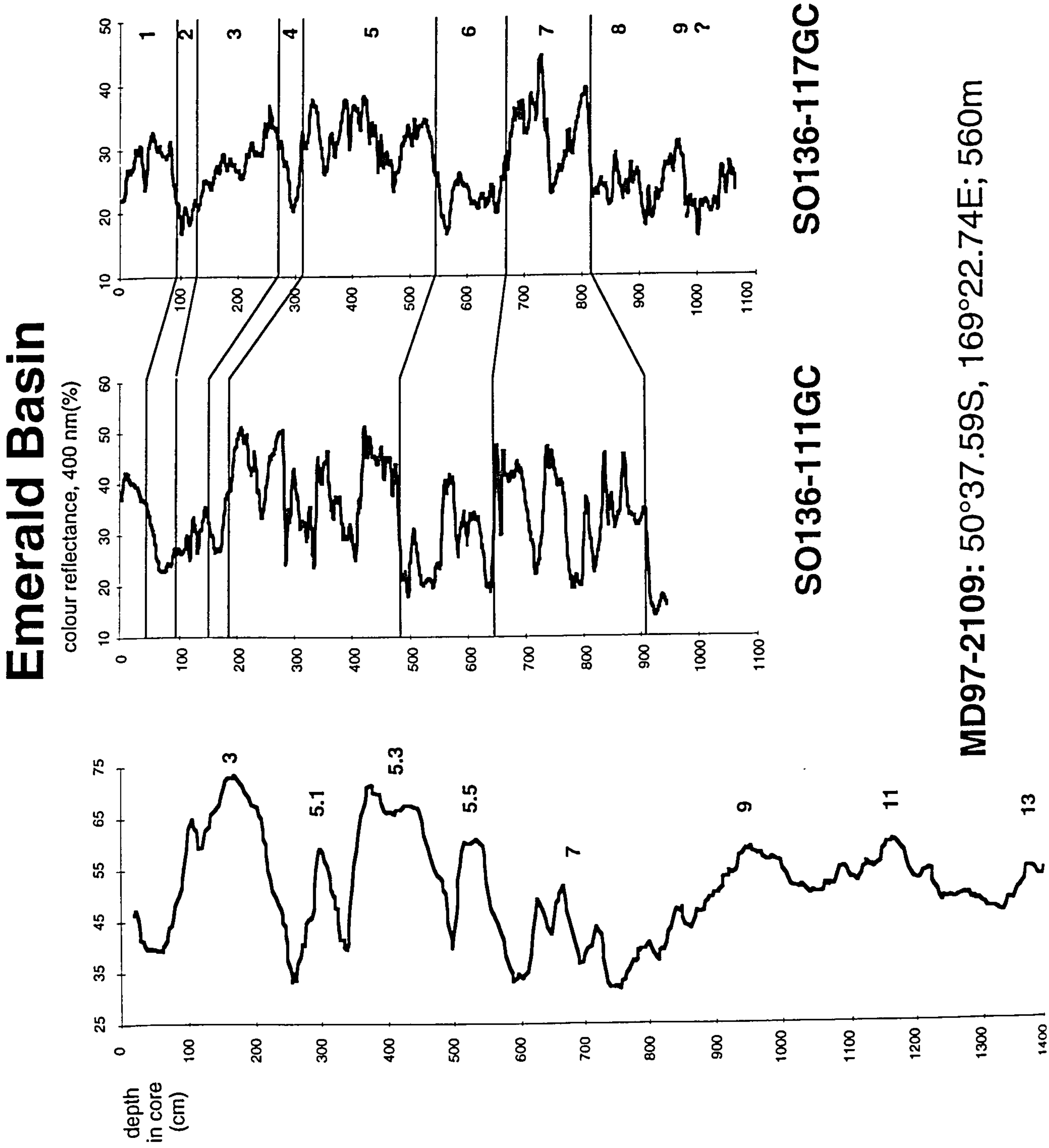
	SO136-005MUC	SO136-011GC	SO136-013BX	SO136-019BX	SO136-025BX	SO136-031BX	SO136-037BX	SO136-043BX	SO136-050BX	SO136-054BX	SO136-060BX	SO136-068BX	SO136-076BX	SO136-082BX	SO136-098BX	SO136-100GC	SO136-110BX	SO136-116BX	SO136-123BX	SO136-138BX	SO136-141BX
Water depth (m)	958	1556	1547	4530	3451	1571	1362	956	756	562	601	981	1108	1681	4163	5009	3907	4462	4196	3022	1690
No. Count	494	258	295	326	452	438	411	534	529	497	662	590	683	646	463	199	553	247	513	711	648
AEQU	0,6	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BULL	21,2	22,7	23,9	8,9	41,6	37,4	29,5	32,0	34,8	26,9	38,5	27,8	37,2	54,4	32,8	4,7	4,2	2,9	13,4	33,6	47,8
CALI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CONG	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CRAS	0,2	1,6	1,3	0,2	1,1	1,1	0,2	1,4	1,2	0,2	0,8	0,9	0,9	2,7	0,6	0,0	0,1	0,0	0,6	1,2	2,3
DEHI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
DIGI	0,0	0,1	0,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
DUTE	0,7	0,0	1,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
FALC	6,9	3,6	3,7	0,0	0,6	0,4	0,5	0,3	2,8	4,5	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
GLUT	5,0	0,3	1,9	0,0	3,7	2,9	6,3	3,7	1,8	4,3	7,4	7,6	8,2	1,3	0,3	0,0	0,1	0,0	0,0	6,7	4,3
HEXA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
HIRS	1,8	1,8	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
HUMI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
INFL	27,2	28,8	30,5	82,1	21,5	10,0	4,2	9,6	11,7	7,4	5,4	7,5	10,4	18,0	9,4	4,7	1,3	6,0	31,8	9,4	13,9
MENA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
NITI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
OBLI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PAL	0,0	0,0	2,3	1,5	17,0	40,0	45,2	35,7	27,5	44,4	26,8	34,9	28,6	19,4	54,9	87,9	92,4	90,1	52,8	29,8	18,9
PAR	15,0	24,6	21,3	6,0	8,2	2,9	6,4	4,0	10,3	10,0	10,0	8,7	4,7	0,4	0,3	2,6	1,5	0,0	1,1	7,4	3,9
PELA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
QUIN	0,5	0,0	0,8	0,0	5,2	3,1	6,0	8,8	5,5	0,0	8,0	9,8	7,1	0,8	1,0	0,0	0,5	1,0	0,0	9,4	5,6
RUBE	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
RUS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SACC	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SACS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SCIT	1,1	0,3	0,8	0,0	0,0	0,0	0,0	0,0	0,8	0,0	0,4	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,3	0,2
TUMI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
TRU.L	14,8	15,5	9,6	1,4	0,8	1,9	1,6	4,5	3,2	2,3	2,4	2,7	2,9	2,4	0,0	0,1	0,0	0,0	0,3	1,9	1,9
TRU.R	2,3	0,1	0,2	0,0	0,0	0,0	0,0	0,0	0,4	0,1	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,1	0,0
UNIV	0,7	0,6	0,6	0,0	0,4	0,1	0,0	0,0	0,0	0,0	0,2	0,1	0,1	0,2	0,4	0,0	0,0	0,0	0,0	0,1	1,0
UVUL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
FLEX	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
TENE	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CONM	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
MEN	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
FORA%	70,3	26,0	25,5	10,8	78,8	81,5	70,9	74,7	75,8	70,3	69,2	79,6	84,2	84,6	61,6	55,0	53,0	29,4	61,9	88,8	96,8
RADS%	0,0	0,0	3,2	2,9	0,7	0,0	0,0	0,0	0,1	0,0	0,5	0,0	0,0	0,0	0,0	n.d.	41,6	41,5	0,7	0,5	0,0
BF%	2,7	7,1	5,9	0,2	1,2	0,7	0,2	2,1	2,3	4,2	9,7	0,9	1,4	0,5	0,0	0,0	1,3	3,6	2,7	1,0	0,9
FRAGM%	27,0	66,8	65,4	86,0	19,4	17,7	28,9	23,3	21,8	25,5	20,6	19,6	14,4	14,9	38,3	45,0	4,0	25,5	34,7	9,7	2,2

Planktic foraminiferal counts on sediment core SO136-013BX and SO136-011GC

	SO136-013BX	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC
No. Count	295	258	442	358	496	556	551	294	373	401	314	364	486	352
Depth Corr. (cm)	0	1	31	61	91	121	151	211	241	271	301	331	361	391
Depth Orig. (cm)	0	1	31	61	91	121	151	271	301	331	361	391	421	451
AEQU	0,0	0,3	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0
BULL	23,9	22,7	27,0	19,2	23,5	24,1	25,2	28,3	35,9	30,2	19,2	24,1	28,3	31,2
CALI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CONG	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CRAS	1,3	1,6	1,5	0,1	1,0	0,2	0,4	1,0	0,3	1,8	2,0	1,7	1,0	3,4
DEHI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
DIGI	0,8	0,1	0,0	0,0	0,2	0,4	0,4	0,0	0,0	0,1	0,3	0,0	1,2	0,0
DUTE	1,2	0,0	0,4	0,1	0,0	0,0	0,0	0,0	0,3	0,0	0,0	0,2	0,0	0,6
FALC	3,7	3,6	3,4	3,9	2,2	0,6	0,3	0,7	1,1	0,0	0,0	0,0	0,5	0,0
GLUT	1,9	0,3	3,2	7,6	5,0	3,5	6,3	8,2	5,7	5,3	6,5	5,5	3,4	7,4
HEXA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
HIRS	1,1	1,8	1,7	0,6	0,0	0,2	0,7	0,3	0,3	0,0	1,3	0,0	0,1	0,2
HUMI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
INFL	30,5	28,8	17,3	14,9	22,9	20,0	14,0	12,5	25,6	12,1	12,0	11,0	12,3	7,1
MENA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
NITI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
OBLI	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PAL	2,3	0,0	1,5	1,2	2,2	2,4	0,0	3,9	1,1	14,0	8,8	10,1	5,3	7,5
PAR	21,3	24,6	36,9	38,0	33,7	36,9	25,1	16,3	12,6	13,7	31,8	28,2	28,6	17,2
PELA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
QUIN	0,8	0,0	0,7	2,8	1,0	4,5	19,7	19,6	9,4	18,9	12,8	13,2	11,6	15,7
RUBE	0,0	0,0	0,0	1,3	0,6	0,0	0,0	0,0	0,0	0,3	0,0	0,3	0,0	0,0
RUS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SACC	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SACS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SCIT	0,8	0,3	0,0	1,2	0,0	1,0	0,0	0,0	0,6	0,0	0,0	0,0	0,5	0,0
TUMI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
TRU.L	9,6	15,5	5,7	8,7	7,0	5,7	7,6	8,7	6,9	3,5	5,0	5,3	6,8	8,8
TRU.R	0,2	0,1	0,1	0,0	0,0	0,1	0,2	0,3	0,0	0,0	0,1	0,3	0,0	0,4
UNIV	0,6	0,6	0,6	0,3	0,6	0,3	0,0	0,0	0,3	0,1	0,2	0,2	0,4	0,4
UVUL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0
FLEX	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
TENE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CONM	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
MEN	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
FORA%	25,5	26,0	49,6	54,8	61,7	71,3	71,1	62,7	52,8	53,8	44,8	48,6	52,6	43,5
RADS%	3,2	0,0	0,0	0,0	0,0	0,0	0,4	0,1	0,2	0,7	0,1	0,0	1,1	6,1
BF%	5,9	7,1	2,4	1,3	1,5	2,5	4,9	3,6	6,5	5,2	5,8	7,4	6,8	4,8
FRAG%	65,4	66,8	48,0	43,9	36,9	26,2	23,5	33,7	40,6	40,3	49,3	44,0	39,6	45,6

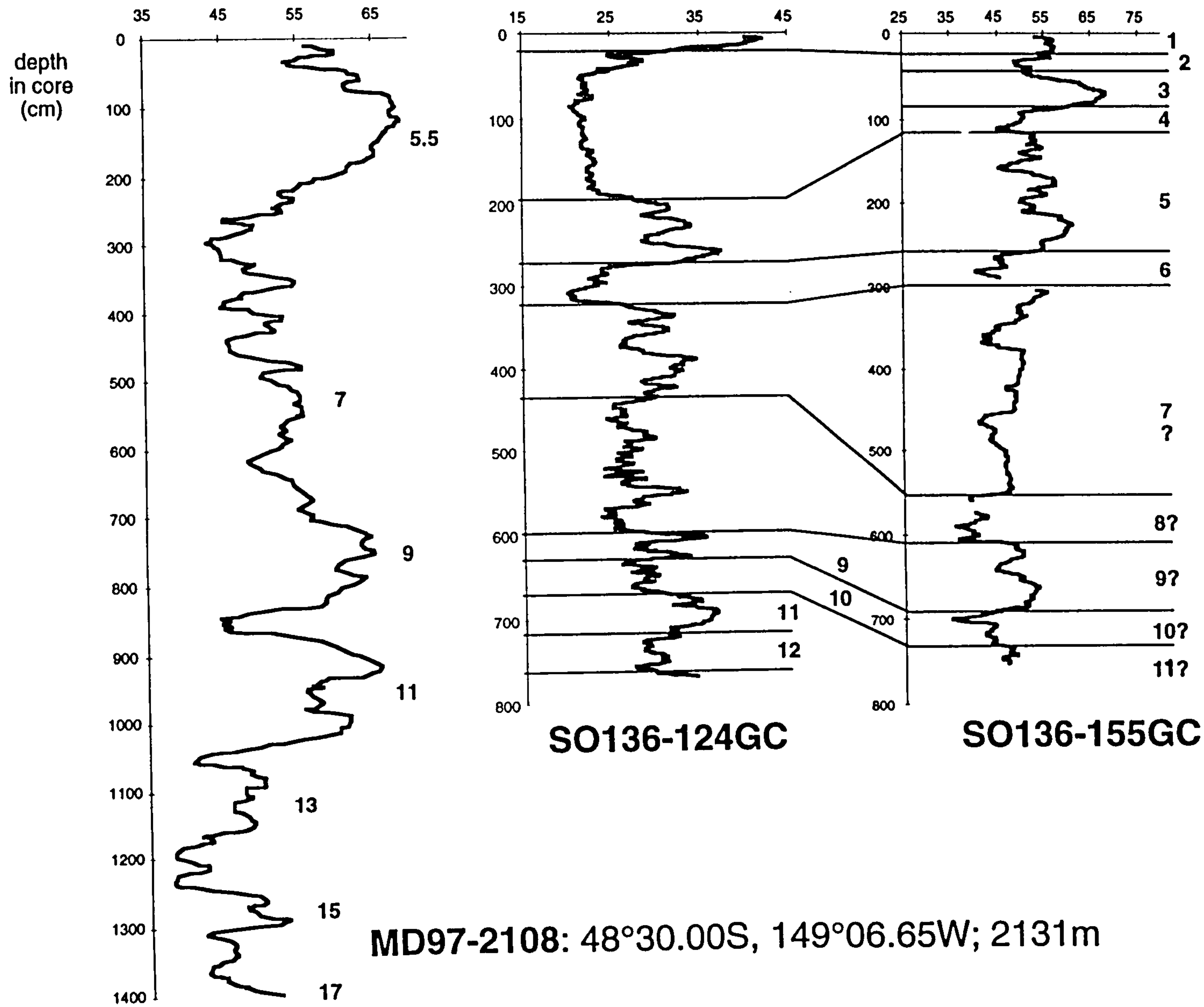
	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC	SO136-011GC
No. Count	437	342	464	457	445	580	550	533	477	367	400	506	275	524
Depth Corr. (cm)	421	451	481	511	541	571	601	631	661	691	721	751	781	811
Depth Orig. (cm)	481	511	541	571	601	631	661	691	721	751	781	811	841	871
AEQU	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
BULL	32,7	25,1	29,3	30,0	20,6	27,6	28,2	32,6	30,0	31,1	18,8	23,7	20,6	21,0
CALI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CONG	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CRAS	3,0	0,0	2,1	1,5	0,2	1,3	1,9	1,7	1,9	0,8	3,0	2,1	2,6	5,5
DEHI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
DIGI	1,2	0,0	1,6	0,0	0,2	0,1	0,3	0,0	0,0	0,0	0,0	0,0	0,5	0,1
DUTE	0,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,2	0,0	0,0	0,4
FALC	0,0	0,0	0,8	0,0	0,9	0,4	0,2	0,0	0,0	0,8	0,7	0,0	0,0	0,0
GLUT	7,9	4,8	5,5	5,7	2,4	6,6	3,4	6,1	2,9	2,3	3,4	4,1	6,0	1,3
HEXA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
HIRS	0,0	0,0	0,1	0,4	0,0	0,0	0,6	0,0	0,1	0,2	0,0	0,4	0,0	0,7
HUMI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
INFL	7,1	9,0	21,0	14,5	21,9	16,9	25,5	20,3	22,4	28,5	18,5	17,4	24,0	16,4
MENA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
NITI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
OBLI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
PAL	3,4	7,4	7,2	7,0	7,3	8,2	5,5	6,6	5,3	3,1	1,8	5,8	5,2	4,4
PAR	30,0	35,6	17,7	22,5	23,8	19,7	22,9	14,8	22,3	27,4	40,6	34,5	32,1	41,5
PELA	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
QUIN	9,7	10,3	10,6	14,2	15,4	17,9	7,8	16,0	14,2	1,5	6,4	7,5	6,3	3,2
RUBE	0,0	0,0	0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
RUS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SACC	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SACS	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
SCIT	0,7	0,0	0,4	0,8	0,0	0,0	0,9	0,1	0,0	0,8	0,0	0,3	0,0	0,0
TUMI	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
TRU.L	3,6	7,0	2,5	3,1	7,1	1,2	1,4	1,2	0,4	2,7	4,8	3,2	1,4	4,1
TRU.R	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6	0,0	0,1	0,0	0,0
UNIV	0,5	0,7	0,5	0,2	0,3	0,1	1,3	0,5	0,4	0,3	1,8	0,9	1,2	1,3
UVUL	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
FLEX	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
TENE	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
CONM	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
MEN	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
FORA%	44,6	41,5	47,1	50,2	49,3	56,7	55,7	61,1	53,0	50,9	44,6	48,1	44,4	56,5
RADS%	6,4	12,4	10,1	7,4	7,1	5,0	5,1	3,4	3,5	5,7	4,9	10,3	6,4	5,9
BF%	6,2	4,7	5,2	5,0	4,6	3,9	3,3	6,6	6,5	7,3	4,3	5,1	3,8	4,3
FRAG%	42,8	41,3	37,6	37,4	38,9	34,3	35,9	28,9	37,0	36,2	46,2	36,4	45,5	33,3


East Campbell Plateau
colour reflectance, 400 nm(%)
SO136-038GC
SO136-044GC
SO136-051GC
SO136-055GC
Coring Disturbance
MD97-2109: 50°37.59S, 169°22.74E; 560m
depth in core (cm)


Emerald Basin
colour reflectance, 400 nm(%)
SO136-111GC
SO136-117GC
MD97-2109: 50°37.59S, 169°22.74E; 560m
depth in core (cm)
1
2
3
4
5
6
7
8
9 ?
3
5.1
5.3
5.5
7
9
11
13

South Tasman Rise

colour reflectance, 400 nm(%)



LEGEND

LITHOLOGY

SAND/SANDSTONE | shaly sand | clayey silt | clay/claystone

silty sand | sandy silt

CONTACTS

Sharp | Bioturbated | Uncertain | Undulating

Inclined

PHYSICAL AND BIOGENIC STRUCTURES

carbonaceous (organic) | parallel lamination | patch

burrow | burrows | foraminifer filled burrow

medium sand fill in burrows | darker mottles | inverse grading/ coarsening upward

normal grading/ fining upward

LITHOLOGIC ACCESSORIES

Gl - Glauconitic | Py - Pyrite | Fe - Ferruginous

Manganese nodules | Mn - Manganese grains | dropstone

ICHNOFOSSILS

Planolites | Chondrites | ichnofossil/burrow, general

Bioturbation

FOSSILS

Algae mats | Diatoms | Echinoderms

Foraminifera (pelagic) | Molluscs (undifferentiated) | Radiolarians

Spines

BIOTURBATION

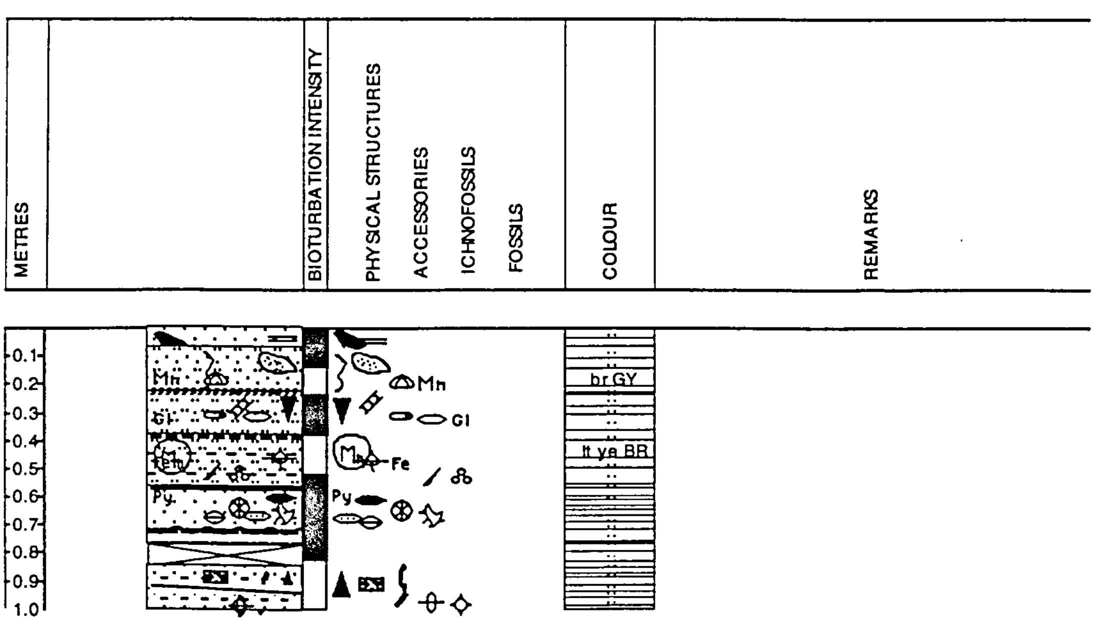
Abundant

Common

Moderate

Rare

Barren

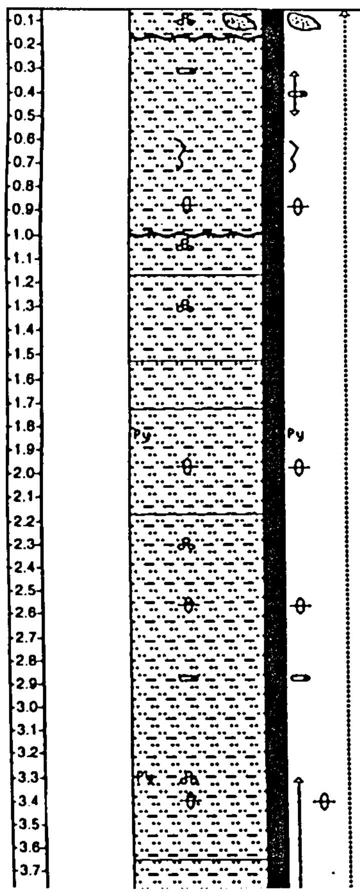


SO136-003GC

Date logged: October, 19th 1998
Logged by: J.R. & H.N.

Site 1, Challenger Plateau
42°17.74 S, 169°52.66 E, W.D. 958 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | COLOUR | REMARKS



pal YE
lt gn GY
gn GY
lt gn GY

0.05-1.00: Very fine sandy foram ooze throughout entire section
Colours: 0.05-0.30: 5Y 8/3 (pale yellow)
0.30-0.80:10GY 7/1 (light greenish gray)
0.55- N7/1 (light greenish gray)
0.80-1.00: 10GY 6/1 (greenish gray)

Burrows: 1. Planolites, small size, length up to 6cm
2. Larger size with different grains
3. smaller size tend to go parallel to layering

1.00-1.29: Very fine sandy foram ooze.
Colour: 1.00-1.29: 10GY 6/1 (greenish gray)
1.17: Slight colour change , upper boundary burrowing.
Burrows: Planolites.

1.29-2.29: Very fine sandy foram ooze with angular siltsized black grains.
Colours: 1.29-1.53: 10GY 671 (greenish gray)
1.53-1.63: 10GY 7/1 (light greenish gray).
large burrows up to 10cm.
1.63-2.11: 10GY 6/1 (greenish gray)
2.11-2.29: 5Y 8/3 (pale yellow) alternating with 10GY 6/1 (greenish gray) .

1.72-2.17: Small scale burrows, parallel to layering.

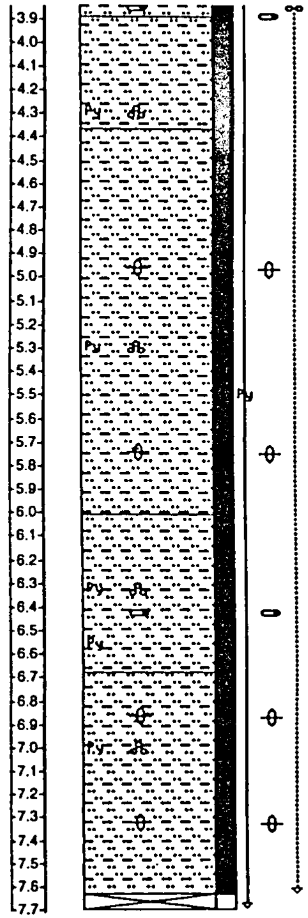
1.88: Return to big burrows.

2.29-3.29: Very fine sandy foram ooze with yellow (5Y 7/3) burrows.
Colour: 2.29-2.59: 10GY 7/1 (greenish gray)
2.59-3.09:10GY 6/1 (greenish gray)
3.09-3.29:10GY 7/1 (greenish gray)

Large Planolites with direction of burrowing.

Large burrows disappear.

3.29 - 3.65 large burrows
3.65 - 4.29 small scale burrows



gn GY

3.29-4.29: Medium to fine sandy foram ooze.
Coarse fraction: Black angular clasts, sponge spicules, pelagic forams.
Colours: 3.29-3.65: 10GY 7/1 (greenish gray)
3.65-3.89: 5GY 7/1 (light greenish gray)
3.89-4.24: 10GY 7/1 (light greenish gray)
4.24-4.29: 10GY 7/1 (greenish gray)

Planolites crossing core.

4.29-5.29: Clayey silty foram ooze, coarser patches with medium sand-infill.
Colours: 4.29-4.37: 10GY 6/1 (greenish gray)
4.37-5.29: 5GY 6/1 (greenish gray)
4.69-485: Pale yellow burrows (2.5Y 8/3).

5.29-6.32: Silty foram ooze with coarser, sand /foram filled burrows of pale yellow colour (2.5Y 8/3).
Colour: 5.29-5.365: 10Y 6/1 (greenish gray)
5.365-5.495: 2.5Y 8/3 (pale yellow)
5.495-6.19: 5Y 7/1 (light greenish gray)
6.19-6.32: 10GY 7/1 (light greenish gray)

Burrows: length 21.5cm, diameter 1cm, colour 2SY 8/3.

6.00 colour-litho-boundary
6.035 colour-litho-boundary

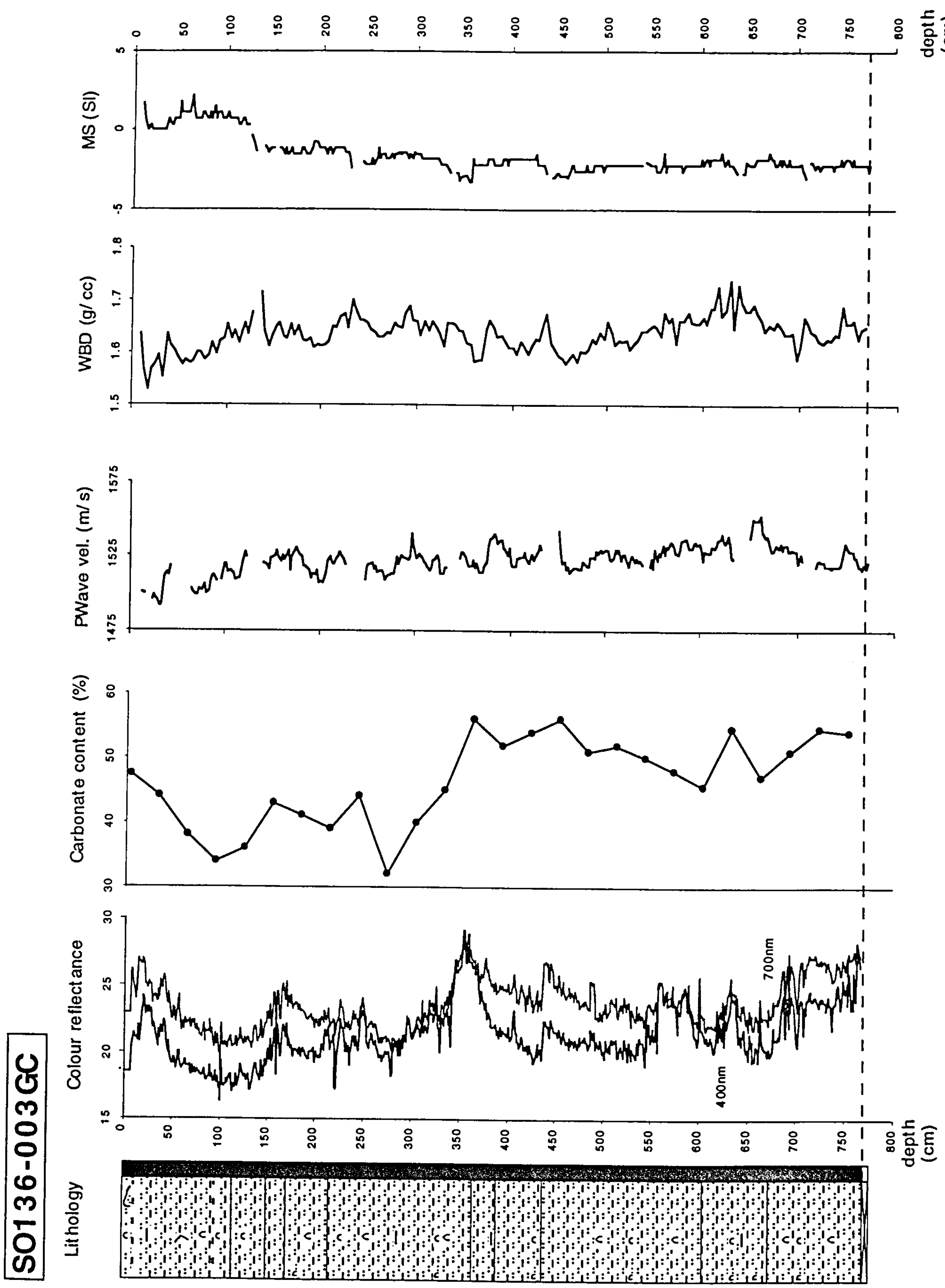
6.32-7.00: Silty foram ooze, foram and medium sand filled burrows.
Colours: 6.32-6.855: 10GY 7/1 (light greenish gray)
6.855-7.00: 5Y 7/1 (light greenish gray)

Semi- lithofied surface, burrow.

7.00-7.70: Silty foram ooze with pale yellow (2.5Y (73) bioturbated mottles and black pyrite streaks throughout.
Colours: 7.00-7.025: 5Y 7/1 (light greenish gray)
7.025-7.48: 10GY 7/1 (light greenish gray)
7.48-7.63: 5Y 7/1 (light greenish gray)

7.63: EOC

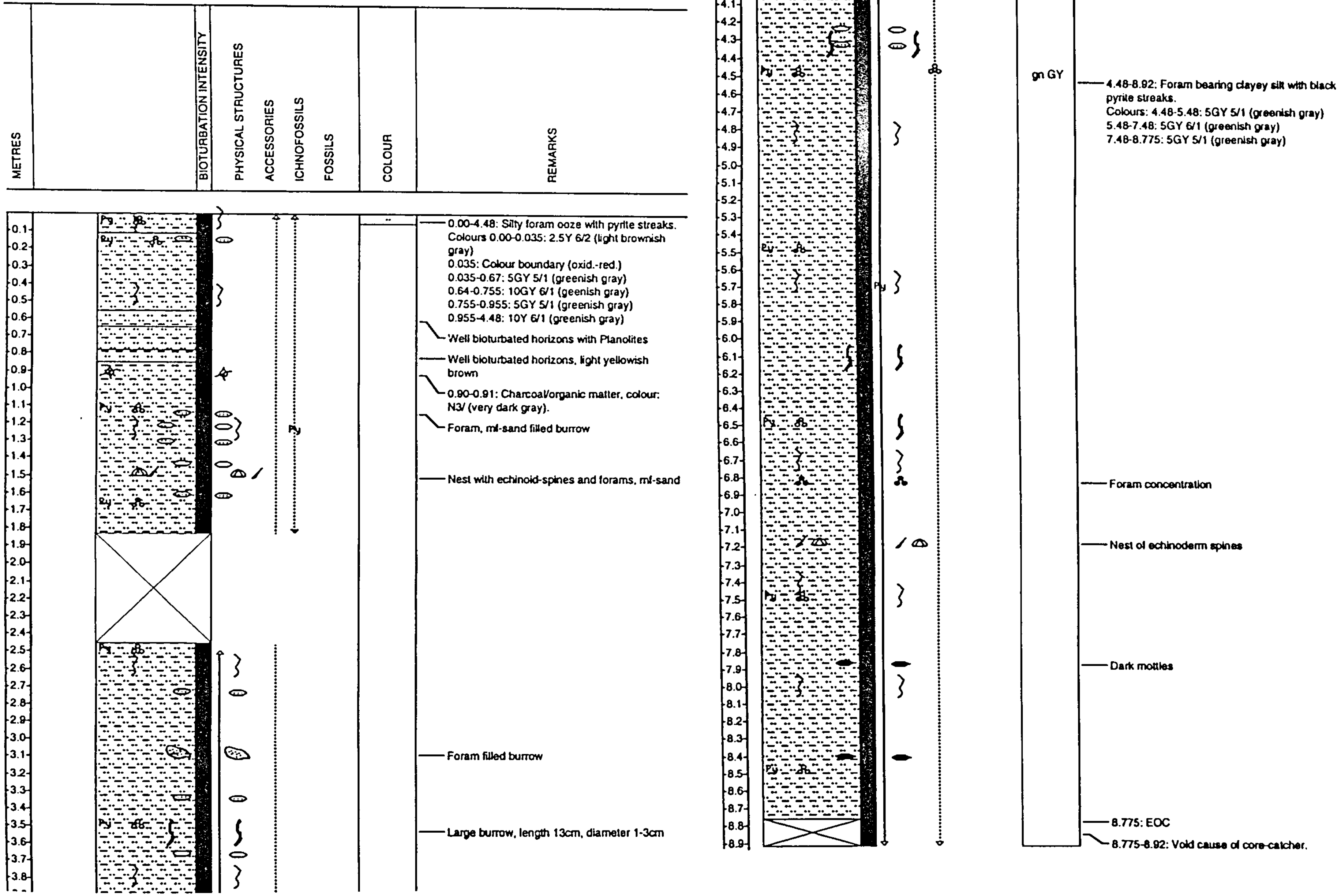
7.63-7.70: Void, due to core-catcher.

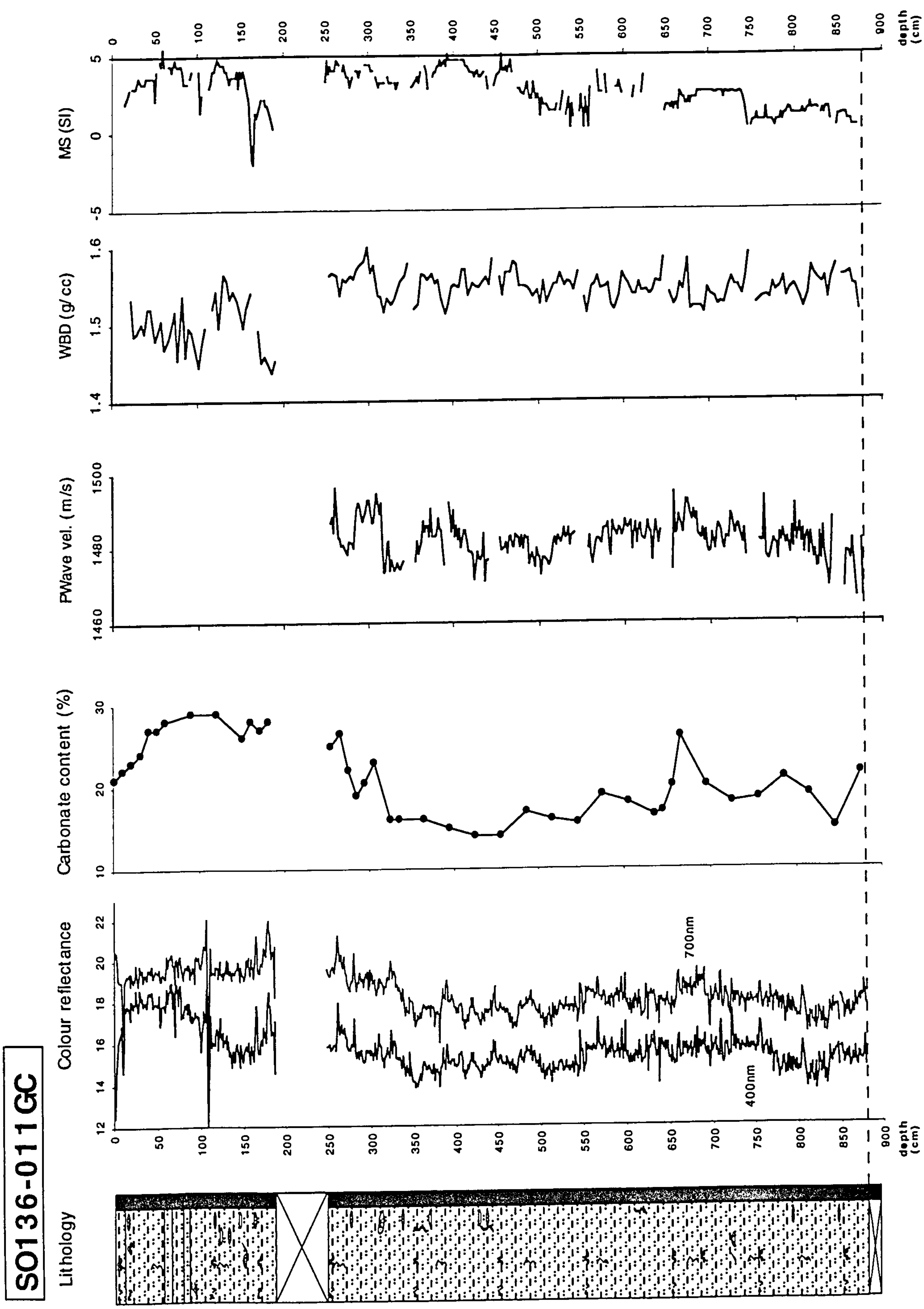

SO136-003GC
MS (SI)
WBD (g/cc)
PWave vel. (m/s)
Carbonate content (%)
Colour reflectance
700nm
400nm
Lithology
depth (cm)

SO136-011GC

Date logged: October, 20th 1998
Logged by: v.d.L.

Site 2, Challenger Plateau
43°26.40 S, 167°51.04 E, W.D. 1556 m



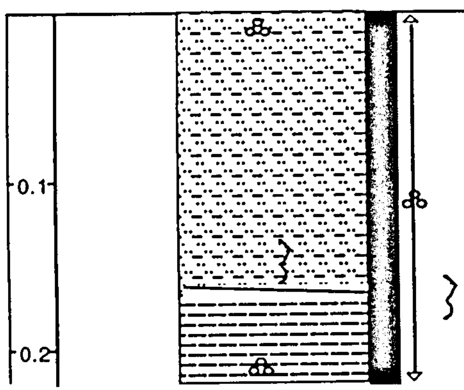

SO136-011GC
MS (SI)
WBD (g/cc)
PWave vel. (m/s)
Carbonate content (%)
Colour reflectance
700nm
400nm
Lithology
depth (cm)

SO136-013BX

Date logged: October 18, 1998
Logged by: S. R. / N. A.

Site 2, Challenger Plateau
43°20.10 S, 167°41.89 W.D., wd 1547 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | REMARKS



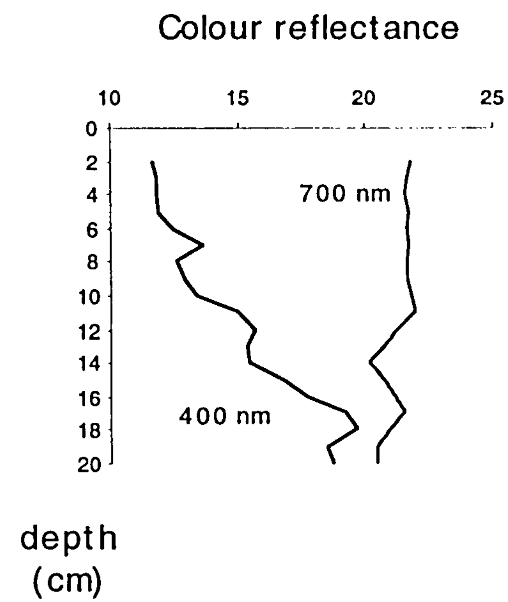
0.00-0.12/0.13: Foram bearing silty clay, colour: 10YR 5/4 (yellowish brown).

0.09-0.11: Burrow (2 X 4 cm) with material from down below.
Colour: 5GY 5/1 (yellowish brown).

0.12-0.13: Transitional boundary.

0.12/0.13-0.22: Clay with some forams, colour: 5GY 5/1 (greenish gray).

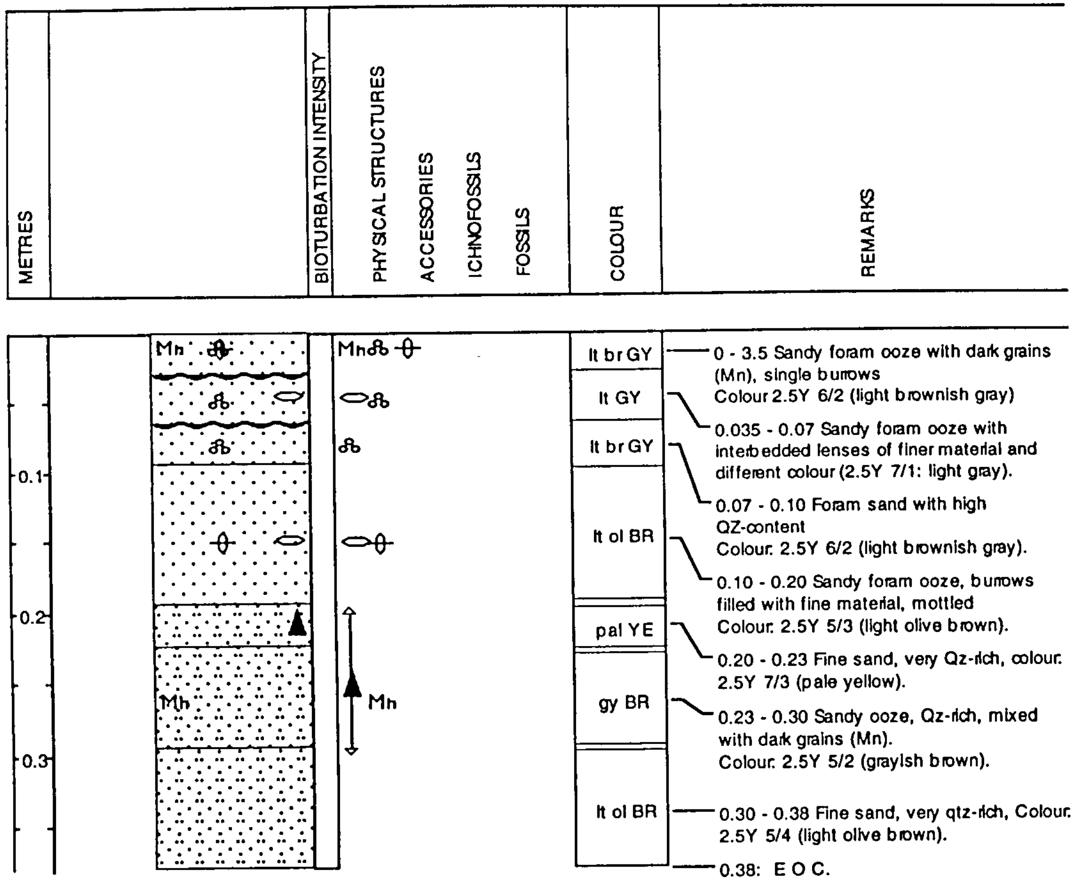
0.22: E O C.

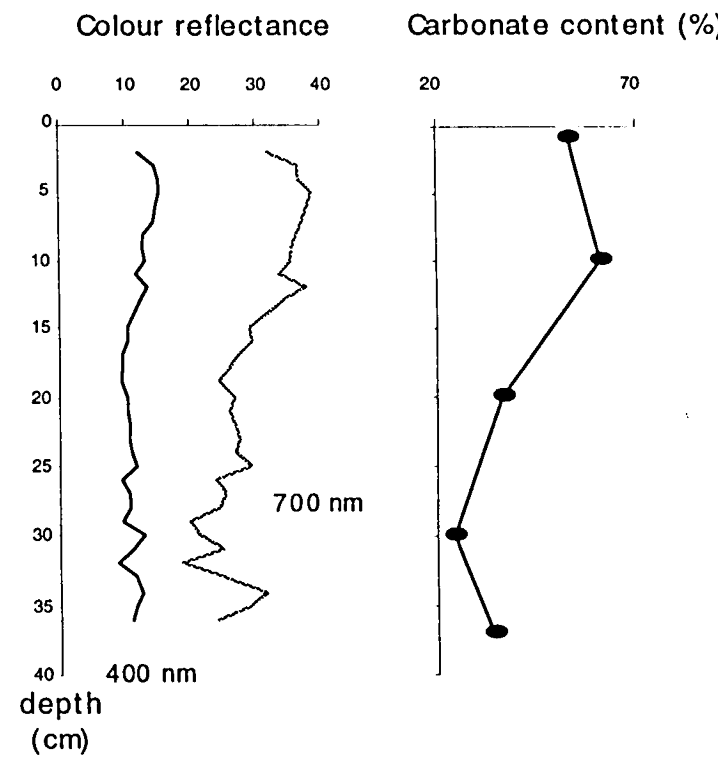


SO136-019BX

Date logged: October 22, 1998 | Site 3, E Campbell Plateau

Logged by: S.N./S.R. | 50°51.08 S, 176°53.20, W.D. 4530 m

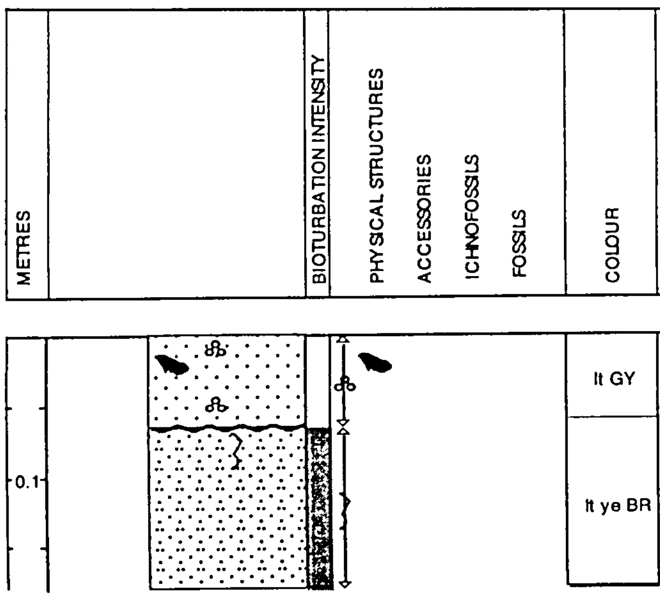




SO136-025BX

Date logged: October 23, 1998
Logged by: A.A./J.R./S.R.

Site 4, E Campbell Plateau
50°39.04 S, 176°22.69 E, W.D. 3451 m



REMARKS

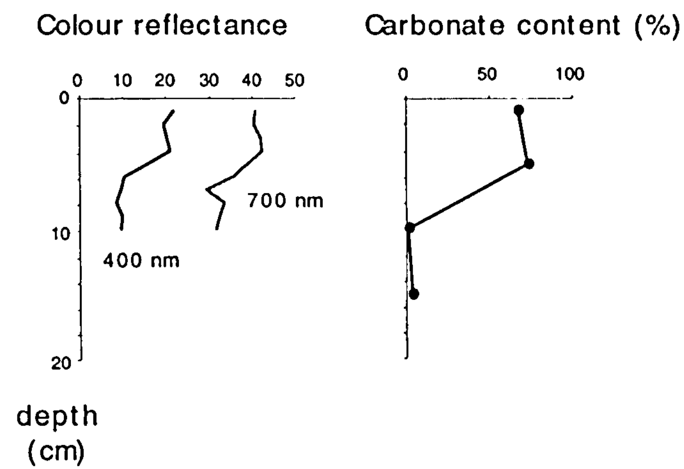
Forams look well preserved, without large-scale corrosion.

0.00-0.06 Silt - fine sand, well sorted. Foram sand (90% forams), low clay content, blackened forams
Accessories: black clasts, volcanic glass (light brown), brown iron minerals, dropstones with manganese crust.
Colour: 2.5Y 7/1 (light grey).

0.06: Undulating erosional surface.

0.06 - 0.19: Fine silt, well sorted, with black streaks.
Colour: 2.5Y 6/4 (light yellowish brown).

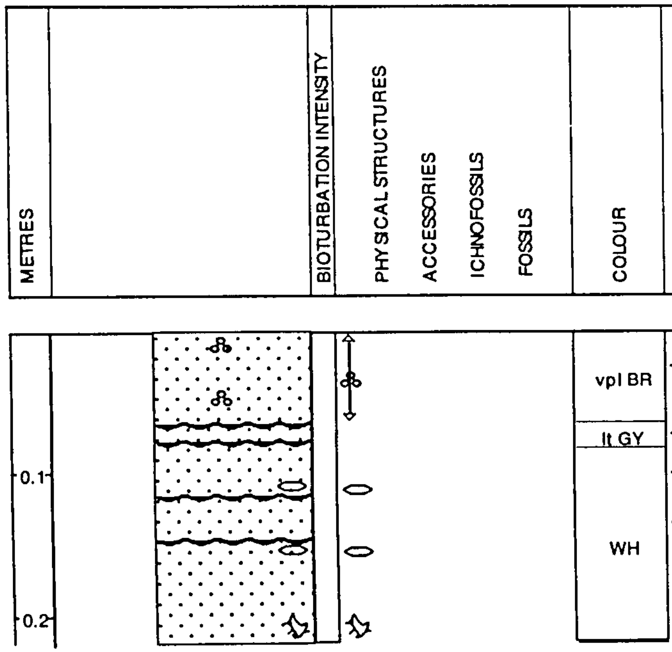
0.19: E O C.



SO136-031BX

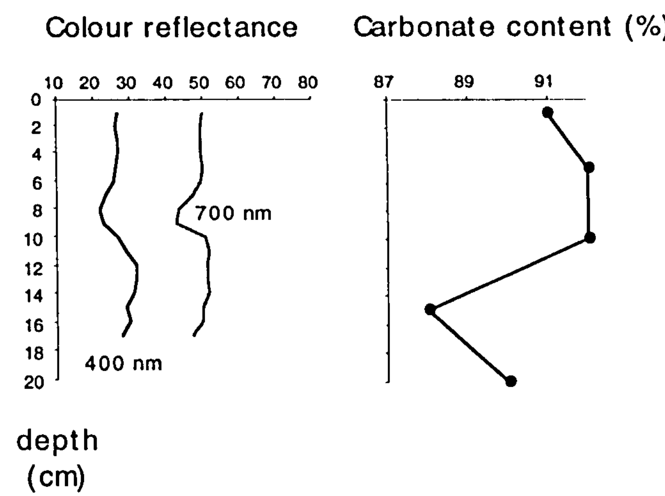
Date logged: October 23, 1998
Logged by: J.R. / A.A.

Site 5, E Campbell Plateau
50°19.82 S, 175°34.85 E, W.D. 1571 m



REMARKS

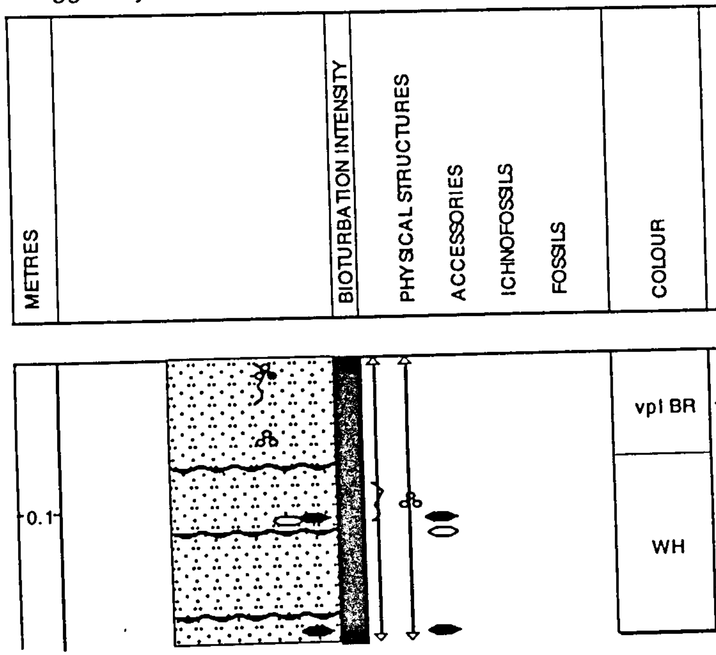
0.00 - 0.07: Coarse foram sand, colour: 10YR 8/3 (very pale brown).
0.07 - 0.08: Fine sand, colour 10YR 7/2 (light gray).
0.08 - 0.12: Medium sand, colour 2.5YR 8/1 (white).
0.12 - 0.15: Coarse sand, colour: 2.5Y 8/1 (white).
0.15 - 0.22: Fine sand, colour 2.5Y 8/1 (white). Bioturbated patch with sediment from below.
0.22: E O C.



SO136-037BX

Date logged: October 23, 1998
Logged by: S.R.

Site 6, E Campbell Plateau
50°13.51 S, 175°19.01 E, W.D. 1362 m



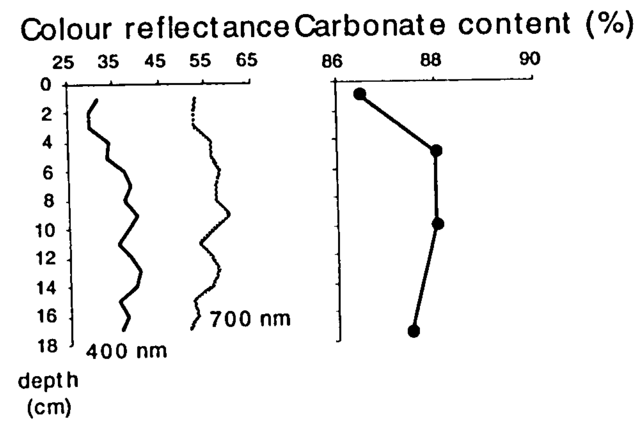
0-0.07: Fine sandy foram ooze, strong bioturbation,
colour: 10YR 8/2 (very pale brown).

0.07-0.12: Fine sandy foram ooze, darker patch (3cm, 10YR 7/2: light gray),
colour: 10YR 8/1 (white), several burrows.

0.12-0.17: Fine sandy foram ooze, colour: 5Y 8/1 (white),
big burrow (4cm) on boundary (12.5cm, 10YR 7/3: very pale brown),
strongly bioturbated.

0.12-0.19: Fine sandy foram ooze, colour: 5Y 8/1 (white),
dark patches and burrows with darker infill.

0.19: E O C.

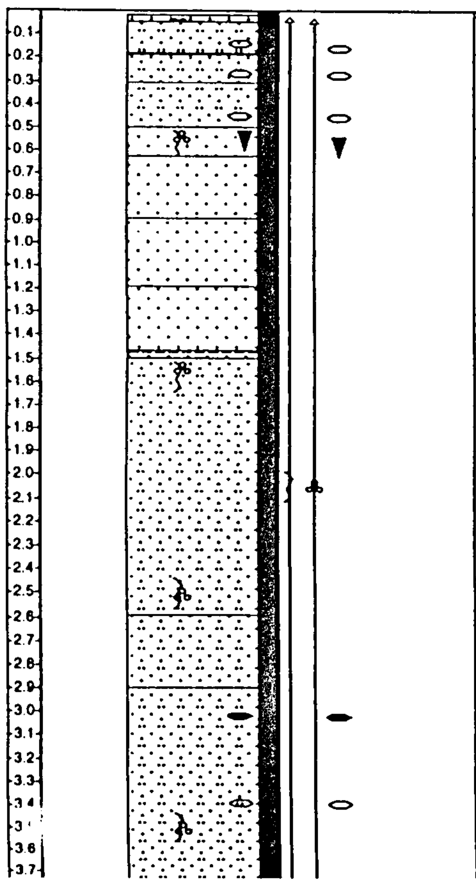


SO136-038GC

Date logged: October 24, 1998
Logged by: J.R. / G.v.d.L.

Site 6, E Campbell Plateau
50°13.43 S, 175°18.73 E, W.D. 1359 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | COLOUR | REMARKS



COLOUR: lt gn GY; gn GY; lt gn GY; gn GY; lt gn GY; lt gn GY / gn GY; WH; pal YE; WH; pal YE; WH; pal OL

REMARKS:

0.02-0.05: Fine sandy foram ooze, colour 10Y 8/1 (light greenish gray).

0.02-0.19: Fine sandy foram ooze, colour 5GY 8/1 (light greenish gray).

0.19-0.31: Medium sandy foram ooze, colour 10Y 6/1 (greenish gray).

0.38-0.50: Foram ooze with varying carbonate-content.
Large Pyrgos represent coarse sand size fragments.

0.50-0.63: Medium sandy foram ooze, fining downwards to fine sandy ooze, colour 10Y 6/1 (light greenish gray).

0.63-0.90: Fine sandy foram ooze with grey streaks, colour 10Y 6/1 (sand), N 8/ (streaks).

0.90-1.20: Fine sand (10Y6/1) with gray streaks (N8/) and some black dots (N4/). Mottles more or less disappear.

1.20-1.50: Colourchange from N7/ (light gray) to N8/ (white).

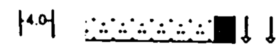
vague colour boundary

1.50-2.50 fine sandy foram ooze, medium to well sorted.
Colours: 1.50-1.55: N8/ (white)
1.55-1.93: 10Y 7/1 to 10Y 6/1 (light greenish gray to greenish gray) 1.93-2.25: 10Y 8/1
2.25-2.35: mixture of colour above and below course of strong bioturbation
2.35-2.50: 10Y 7/1 to 10Y 6/1 (light greenish gray to greenish gray).

2.50-3.50: Fine sandy foram ooze, colour: 2.50-2.53.5: 5Y 6/3 (pale olive)
2.535-2.60: 5Y 8/1 (white).

2.60-2.90: Medium sandy foram ooze, colour: 5Y 8/2 (pale yellow).
Large dropstone (3-4cm).

2.90-3.50: Fine sandy foram ooze, colour 2.90-3.00: 5Y 8/1 (white)
3.00-3.18: 5Y 7/3 (pale yellow), dark

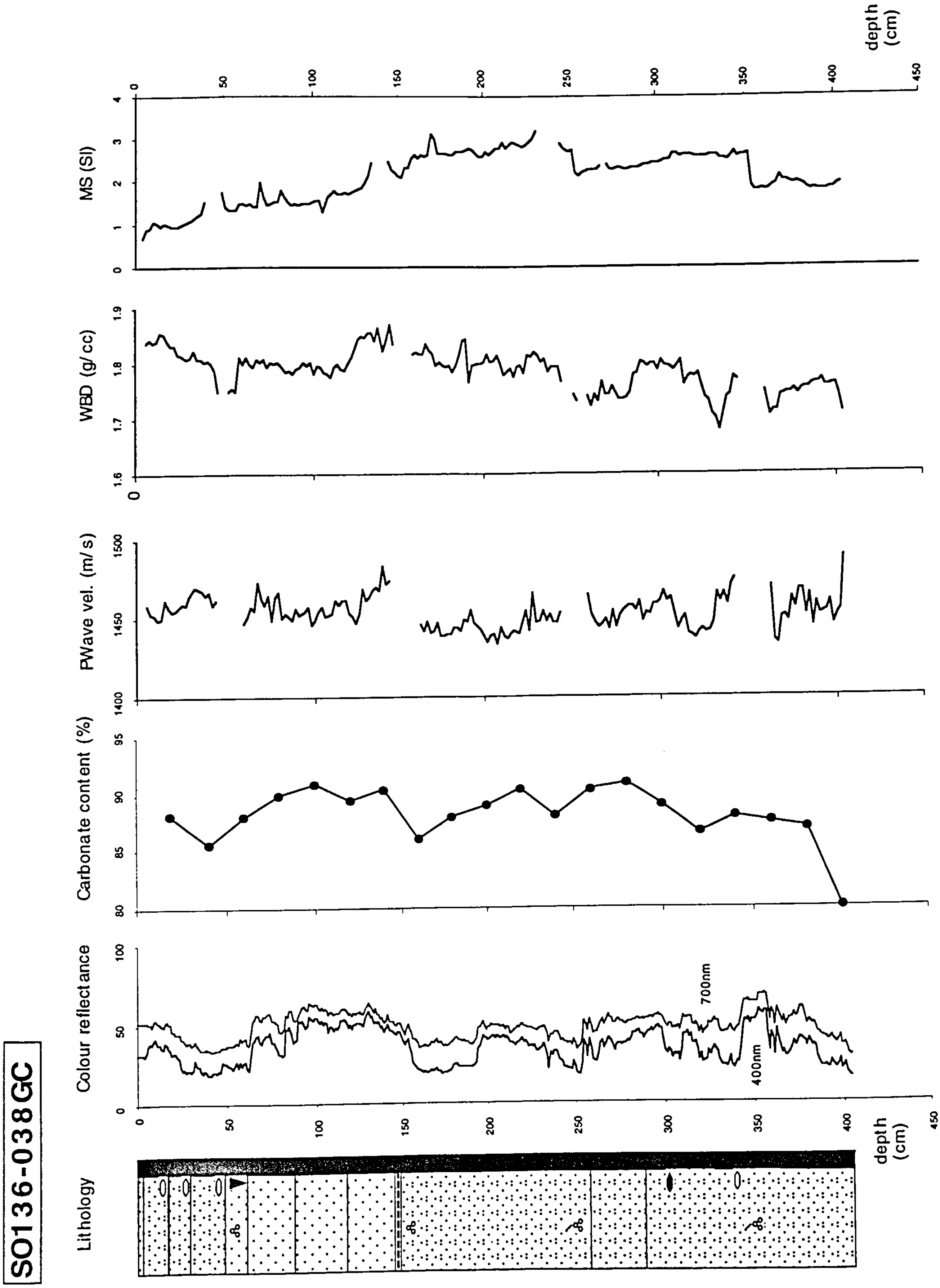


lt GY

3.31-3.41: 5Y 7/3 (pale yellow)
3.41-3.50: 5Y 8/1 (white).

3.50-4.07: Fine sandy foram ooze, mottles and strong bioturbation,
colour 3.50-3.56: 5y 8/1 (white)
3.56-3.64: 5Y 6/3 (pale olive)
3.64-3.68: 5Y 7/2 (light gray)
3.68-3.85: 5Y 7/2 & 5Y 8/2 (light gray & pale yellow)
3.85-4.07: 5Y 6/3 (pale olive) with light gray streaks (2.5Y 7/2).

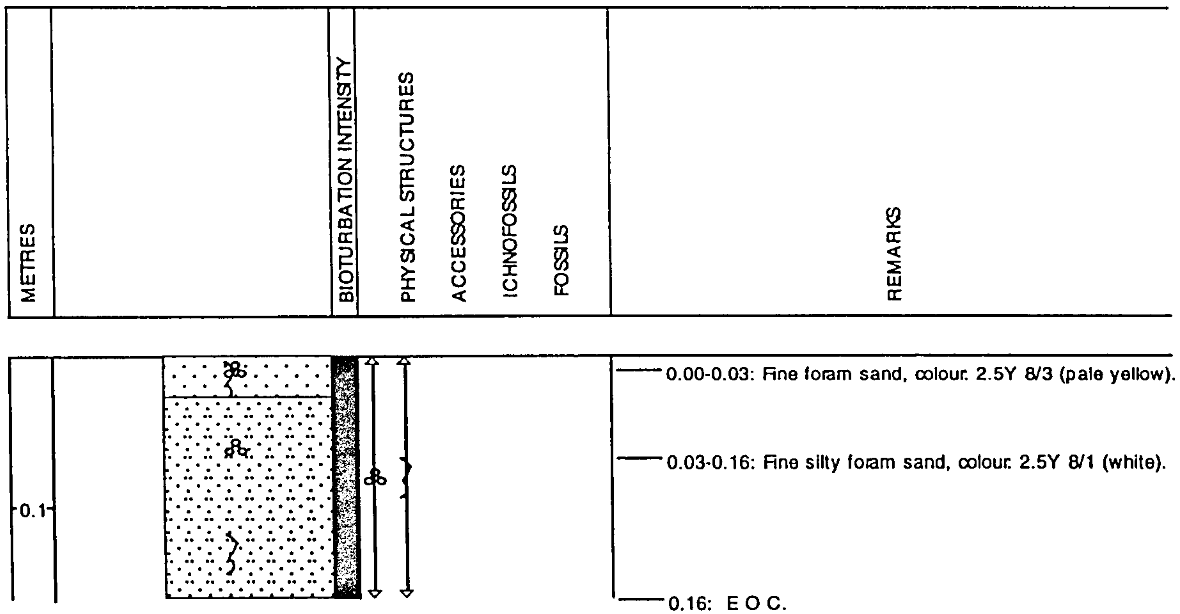
4.07: EOC

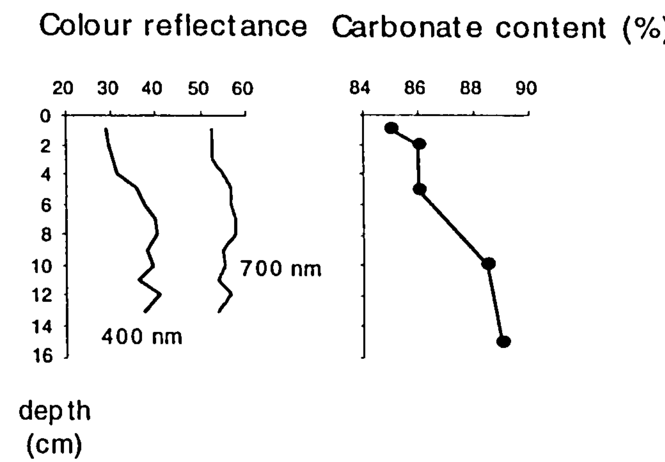

SO136-038GC
MS (SI)
WBD (g/cc)
PWave vel. (m/s)
Carbonate content (%)
Colour reflectance
700nm
400nm
Lithology
depth (cm)

SO136-043BX

Date logged: October 23, 1998
Logged by: J. R. / S. R.

Site 7, E Campbell Plateau
50°07.86 S, 174°41.31 E, W.D. 956 m

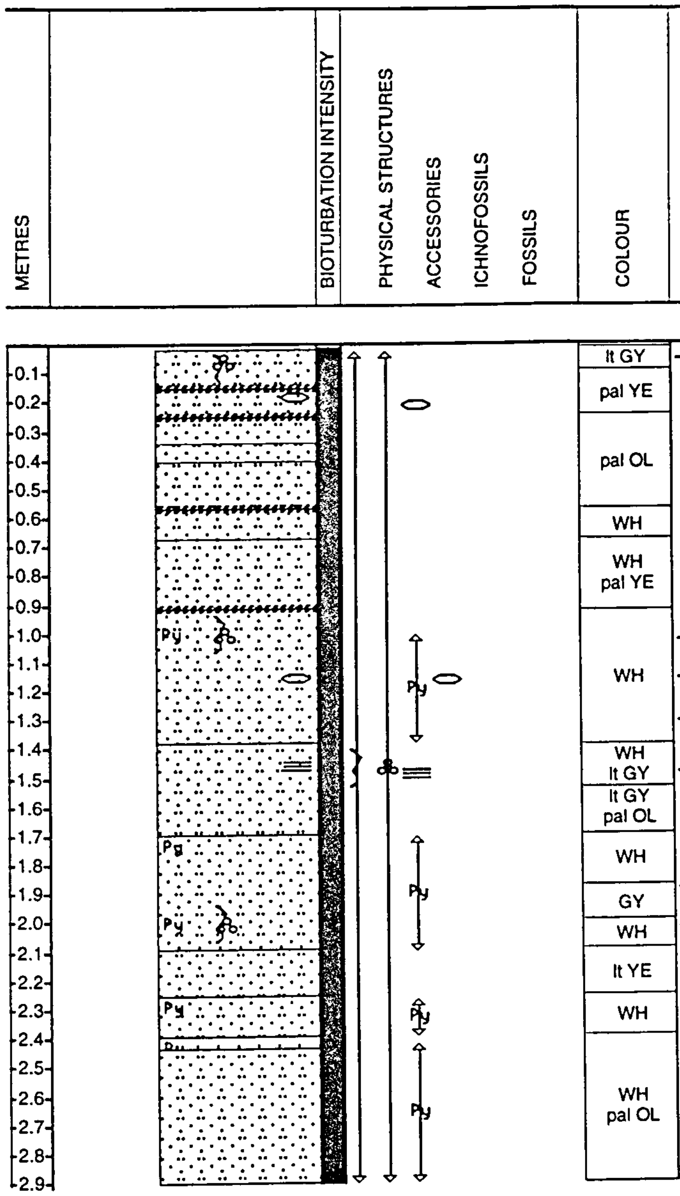




SO136-044GC

Date logged: October 26, 1998
Logged by: G.v.d.L. / J.R.

Site 7, E Campbell Plateau
50°07.91 S, 174°41.49 E, wd 959 m



0.02-0.35: Fine sandy foram ooze
0.35-0.47: Medium sandy foram ooze
0.47-1.00: Fine sandy foram ooze
Colours 0.02-0.09: 5Y 7/2 (light gray), gradual colour boundary to
0.09-0.25: 5Y 8/2 (pale yellow)
0.25-0.35: 5Y 6/3 (pale olive)
0.35-0.41: 5Y 5/4 (pale olive), coarser & darker than above & below
0.41-0.57: 5Y 6/3 (pale olive)
0.57-0.92: 5Y 8/1 (white) and 5Y 7/3 (pale yellow)
0.92-1.00: 5Y 8/1 (white)
There are no clear sediment structures. Visible sedimentary changes are dominated by bioturbation and colour boundaries.

1.00-2.00: Fine sandy foram ooze.
Colours:1.00-1.39: 5Y 8/1 (white), sharp boundary to below
1.39-1.70: 5Y 8/1 (white), 5y 7/2 (light gray) and 5Y 6/3 (pale olive) in (parallel) lamination
1.72-2.00: 5Y 8/1 (white) changing to 5Y 7/2 (light gray). Again black pyrite streaks.

1.16: Burrow filed with material from below, colour: 5Y 6/2 (light olive gray)

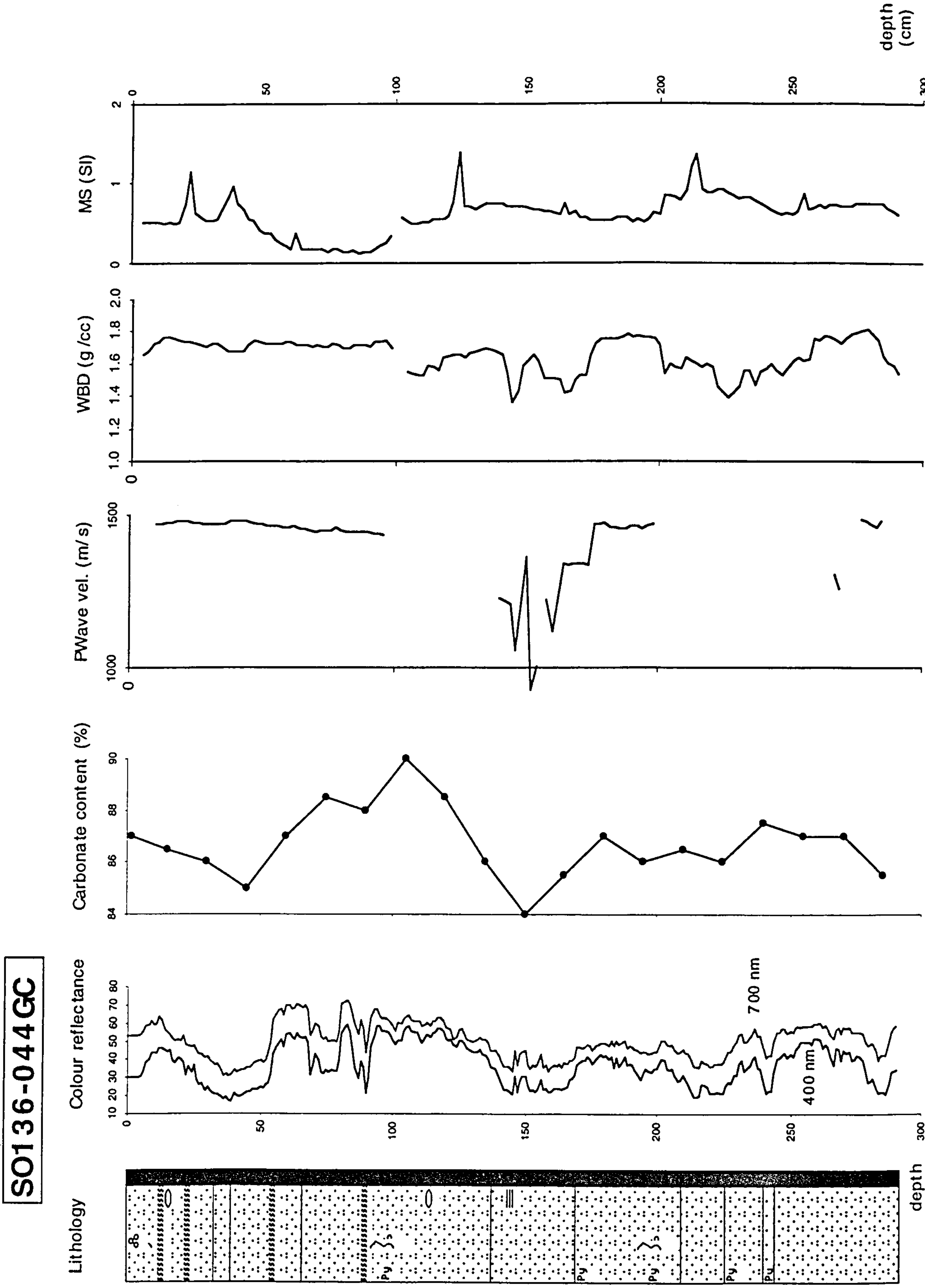
1.00-1.39: Black pyrite streaks parallel and at angle (45°).

1.46-1.51: Faint parallel lamination. Mosaic building white shrinkage-streaks with white infill (5Y 8/1).

1.70-2.00: Black pyrite streaks parallel and at angle (45°).

2.00-2.91: Fine to medium sandy foram ooze. All boundaries are mainly built by colour-changes, gradually and heavily bioturbated. A few pyrite streaks in the white intervals (5Y 8/1).
2.40-2.44: Medium sandy foram ooze, colour 5Y 7/3 (pale yellow)
Colours 2.00-2.10: 5Y 8/1 (white)
2.10-2.26: 5Y 7/3 (pale yellow)
2.26-2.50: 5Y 8/1 (white)
2.50-2.54: 5Y 6/3 (pale olive)
2.54-2.91: 5Y 8/1 (white) and 5Y 6/3 (pale olive) in lamination.

2.91: E o c.

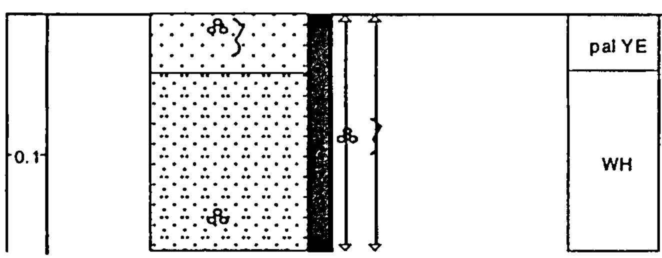

SO136-044GC
depth (cm)
MS (SI)
WBD (g/cc)
PWave vel. (m/s)
Carbonate content (%)
Colour reflectance
700 nm
400 nm
Lithology
Py

SO136-050BX

Date logged: October 24, 1998
Logged by: J.R.

Site 8, E Campbell Plateau
50°06.55 S, 174°16.02 E, W.D. 756 m

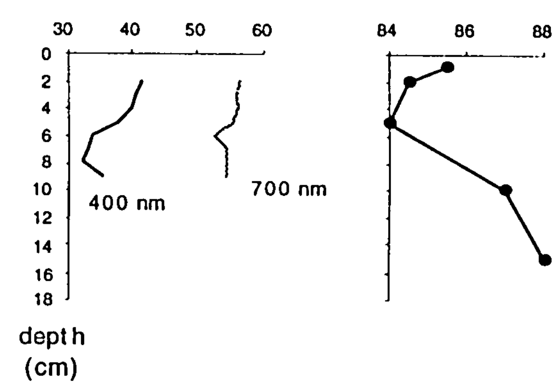
METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ACCESSORIES	ICHNOFOSSILS	FOSSILS	COLOUR	REMARKS



0.00-0.04: Medium sandy foram ooze. Colour 2.5Y 8/2 (pale yellow).

0.04-0.17: Fine sandy foram ooze, strongly bioturbated. Large burrows (cm-scale). Colour is changing from N8/ (white) to 5GY 7/1 (light greenish gray).

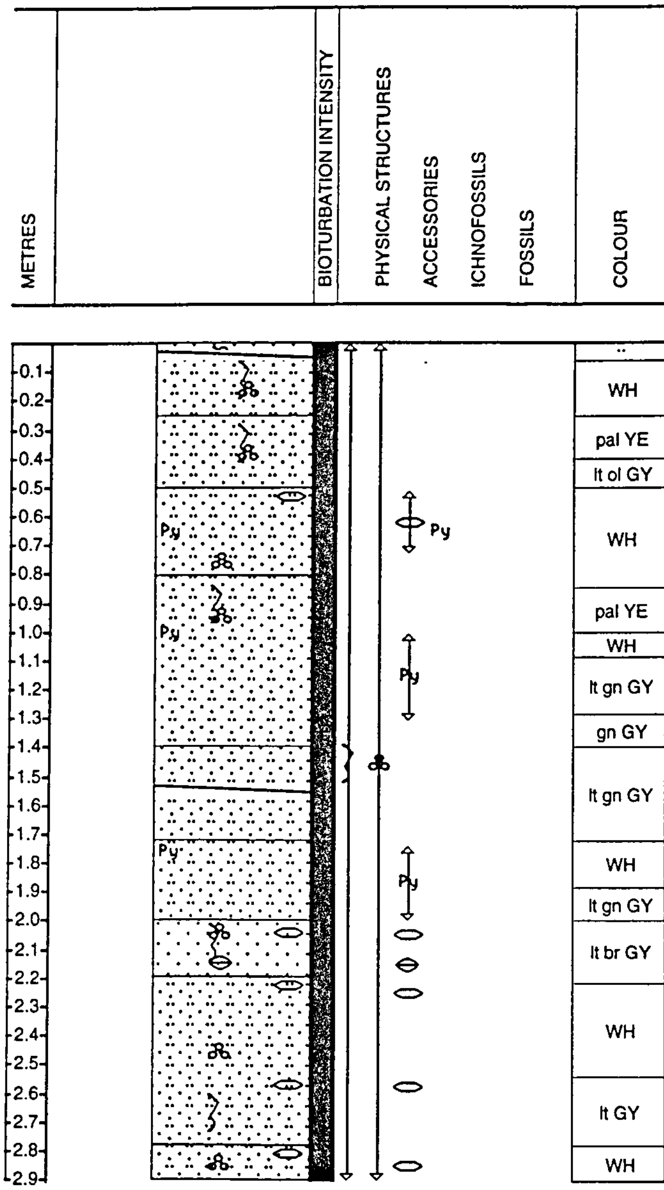
0.17: E O C.



SO136-051GC

Date logged: October 26, 1998
Logged by: J.R.

Site 8, E Campbell Plateau
50°06.88 S, 174°15.57 E, wd 760 m



0.00-0.35/0.10:Pale yellow, sand supported fine sandy foram ooze.
0.035-0.10: Inclined colour-boundary. Colour changes from 2.5Y 8/2 (pale yellow) on top to 2.5Y 8/1 (white) below.
0.035/0.10-0.25: Fine sandy foram ooze with some more silt content, fining downward up to silt supported fine sandy foram ooze.
0.25-0.50: Silt supported sandy foram ooze grading into medium sandy foram ooze. Colour turning from 5Y 7/3 (pale yellow) to 5Y 6/2 (light olive gray).

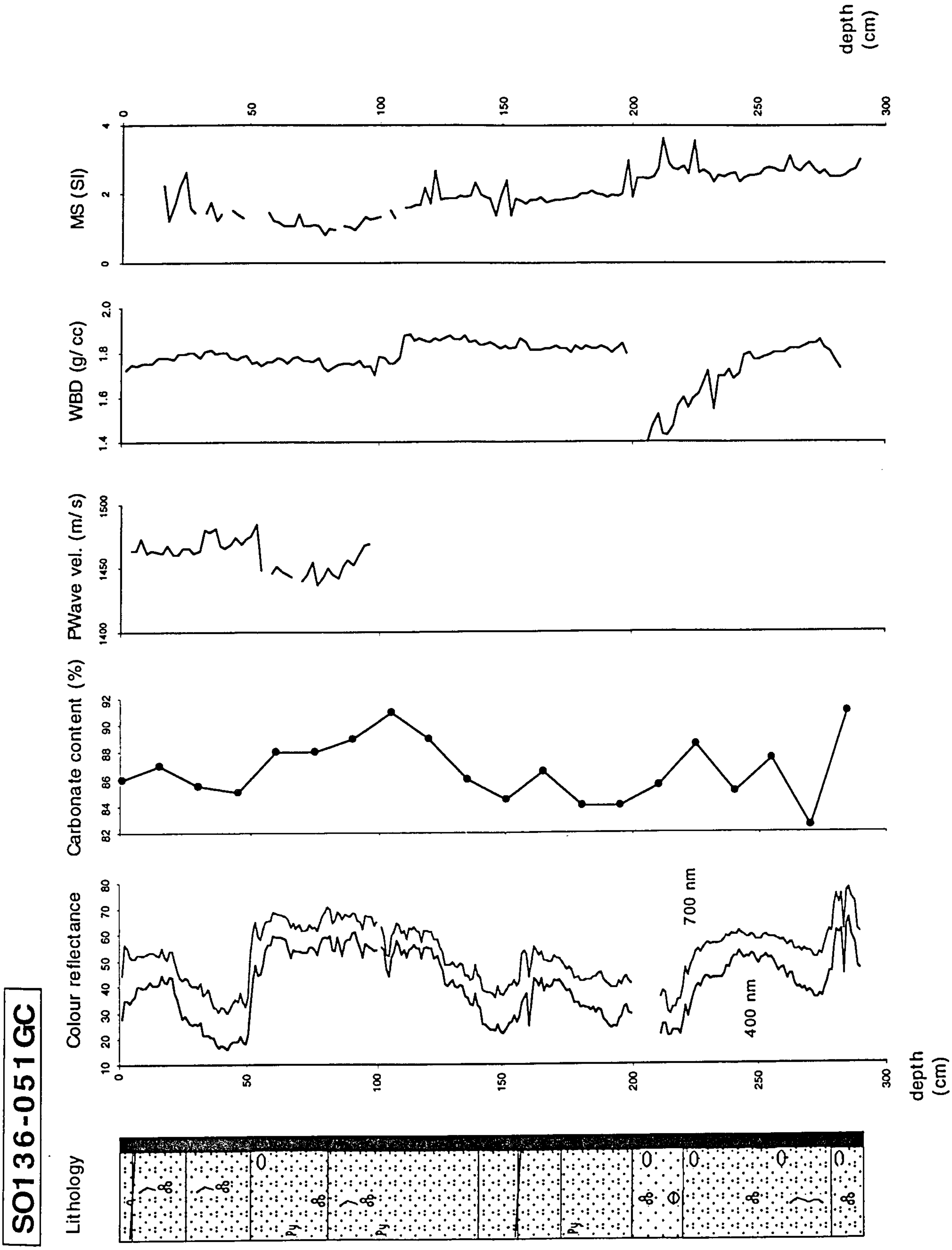
0.50: Lithostratigraphic boundary. Bored , semi-lithified surface. Burrows going down up to 0.70-0.75m (core depth).

0.50-1.00: Fine sandy foram ooze.
Colour variations: 5Y 8/1 (white) grading into 5Y 7/3 (pale yellow).
0.67: Pyrite streaks.

1.00-1.40: Fine sandy foram ooze, coarsening downwards. The colour changes from N 8/ (white) over 10Y 7/ (light greenish gray) to 10Y 6/ (greenish gray).
1.00-1.30: Purpel coloured pyrite streaks.
1.40-2.00: Fine sandy foram ooze.
Colour 1.40-1.73: 10Y 8/ (light greenish gray)
1.73-2.00: Gradual transition from N8/ (white) to 10Y 8/ (light greenish gray)
1.55-1.56: Semi-lithified surface.
1.73-2.00: Several pyrite grains.

2.00-2.20: medium sandy foram ooze, colour 2.5Y 6/2 (light brownish gray)
2.15: Brachiopode shell (2cm), burrowers.
2.20: Semi-lithified surface.
2.20-2.78: Fine sandy foram ooze, slightly coarsening downwards, rare block grains.
Colours 2.20-2.33/2.39: 2.5Y 8/1 (white), inclined boundary.
2.33/2.39-2.50/2.58: N8/ (white), inclined boundary.
2.50/2.58-2.78: 5Y 7/2 (light gray).
2.78: Semi-lithified surface.
2.78-2.90: Fine silty foram ooze, rare sand grains. Single zig-zag burrow Colour: 2.5Y 8/1 (white).

2.90: EOC.

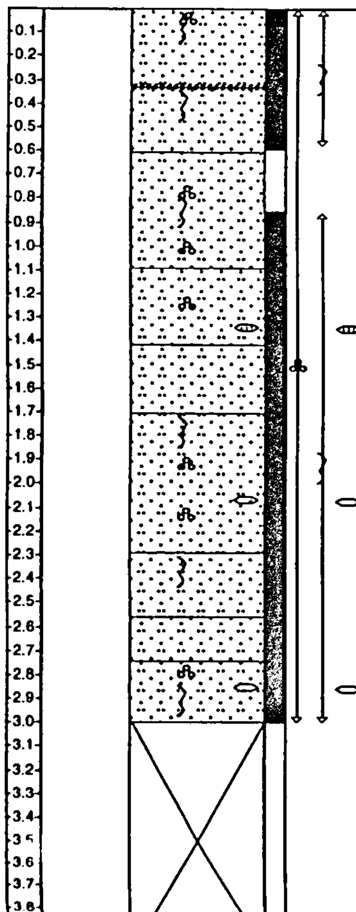

SO136-051GC
MS (SI)
WBD (g/ cc)
PWave vel. (m/ s)
Carbonate content (%)
Colour reflectance
700 nm
400 nm
Lithology
Py
depth (cm)

SO136-055GC

Date logged: October 27, 1998
Logged by: G.v.d.L. / J.R.

Site 9, E Campbell Plateau
50°09.61 S, 173°21.91 E, W.D. 563 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | COLOUR | REMARKS



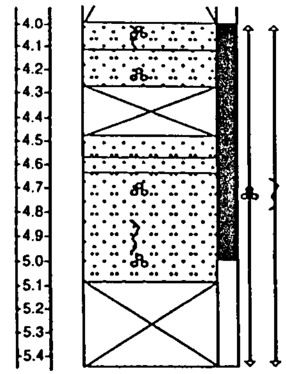
lt GY
WH
WH
lt gn GY
lt GY
WH
lt GY
GY
WH
lt GY
GY
WH
ol GY

0.00-0.33: Fine sandy foram ooze. Colour changing from 5Y 7/2 (light gray) to 5Y 6/3 (pale olive).
0.33: Bioturbated firmground.
0.33-0.61: Fine sandy foram ooze.
Colour: N8/ (white)
0.61-0.85 Disturbed and fluidized due to movement during storm after recovery. Unit of white fine sandy foram ooze (5y 7/1) with light greenish gray streaks (5y 7/3).
0.85-1.00: Fine sandy foram ooze of light gray colour (N7/).
Black grains all over the core section.

1.00-1.10: Light gray (5Y 7/1) fine sandy foram ooze with variable % of fine sand.
1.10-1.42: Fine sandy foram ooze. Gradual colour boundary,inclined, over light gray (5Y 7/2) to white (5Y 8/1). Clear bioturbation and coarse big burrows in the white unit.
1.27-1.29: Semi-lithified firmground, bioturbated.
1.42: Bioturbated firmground.
1.42-2.00: Very fine sandy foram ooze.
Colour 1.42-1.71: 10YR 8/1 (real white)
1.71-2.00: 5Y 7/2 (light gray).
There are black grains all over the core section.

2.00-2.30: Fine sandy foram ooze. Colour changes from 5Y 7/2 (light gray) to 5Y 6/1 (gray).
2.27-2.28: Nest of brachiopods and spines.
2.30: Bioturbated firmground with irregular surface.
2.30-2.56: Fine sandy foram ooze of white colour (10YR 8/1).
2.56-2.75: Light gray (5Y 7/1) fine sandy foram ooze changes to gray (10YR 8/1).
2.75: Bioturbated firmground with irregular surface.
2.75-3.00: White (5Y 8/1) fine sandy foram ooze with dark burrows of olive gray colour (5Y 5/2).
Black grains all over the core section.

Entire core section is stretched and slumped. Disturbance occurred in the lab, due to storm and falling off the table, which partly fluidized the sediment. Description is not possible!!!

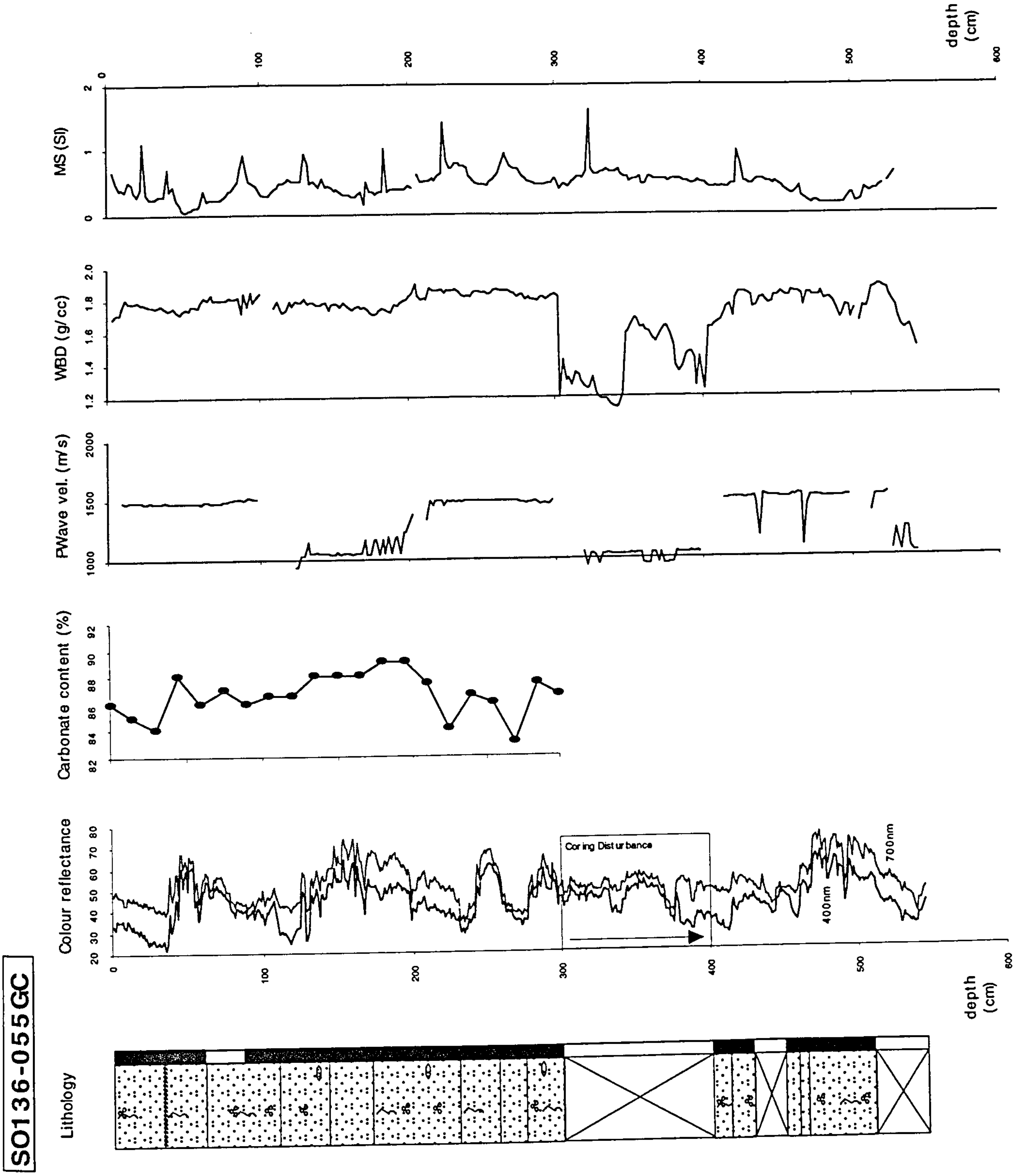


lt GY
lt GY
WH
lt GY
lt GY
lt GY

4.00-4.13: Light gray (5y 7/2) fine sandy foram ooze.
4.13-4.28: Light gray (5Y 7/1) fine sandy foram ooze.
4.28-4.49: Disturbed and mixed unit probably due to storm influence.
4.49-4.58: Light gray (5Y 7/2) fine sandy foram ooze.
4.58: Firm ground.
4.58-4.64: White (5Y 8/1) fine sandy foram ooze.
4.64-5.00: Burrowed mixture, (all colours)
Black grains throughout the core section.

5.00-5.10: Fine sandy foram ooze. The colour is a mixture of 10YR 8/1 (real white) and 5Y 8/1 (white).
5.10-5.45: Fine sandy foram ooze of mixed colour: Light gray and light olive gray (5Y 7/2, 5Y 6/2, 5Y 7/1), probably disturbed, as well storm influence.

5.45: EOC.

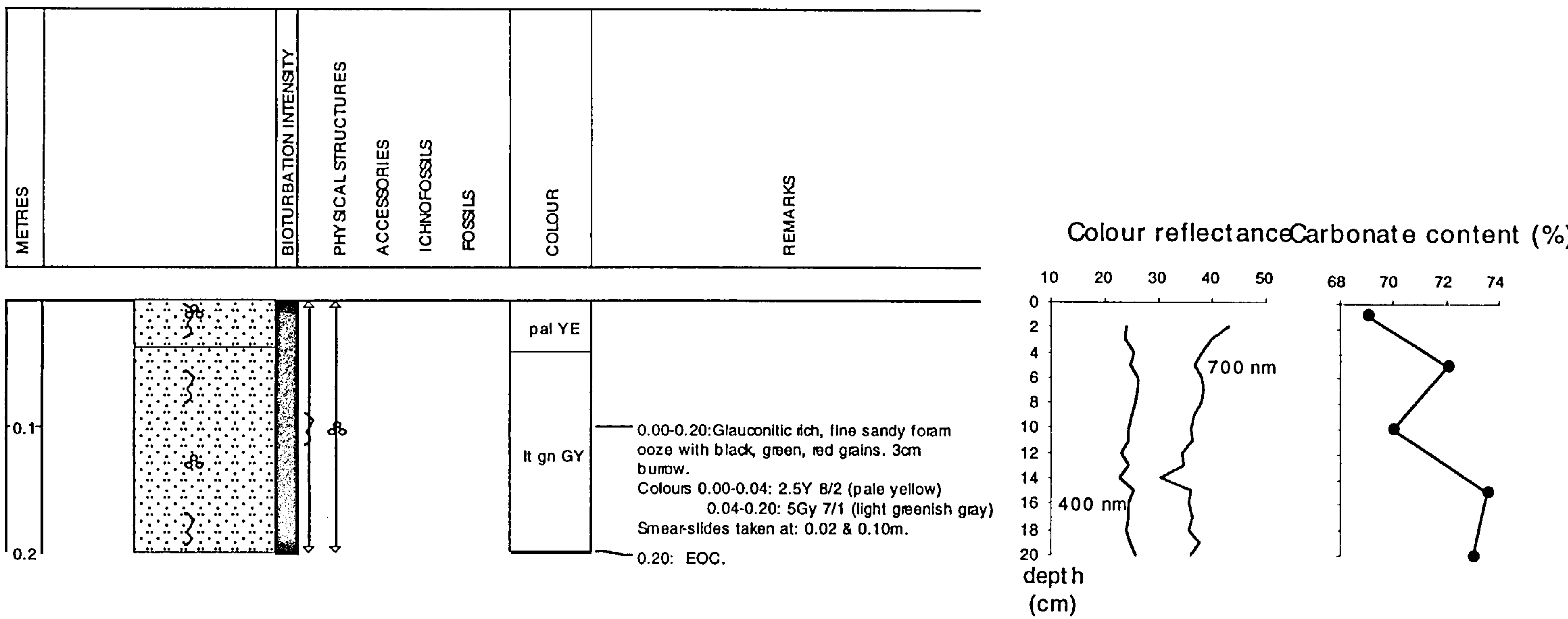


SO136-055GC
depth (cm)
0
100
200
300
400
500
600
MS (SI)
0
1
2
WBD (g/cc)
1.2
1.4
1.6
1.8
2.0
PWave vel. (m/s)
1000
1500
2000
Carbonate content (%)
82
84
86
88
90
92
Colour reflectance
20
30
40
50
60
70
80
Coring Disturbance
400nm
700nm
Lithology

SO136-060BX

Date logged: October 27, 1998
Logged by:J.R.

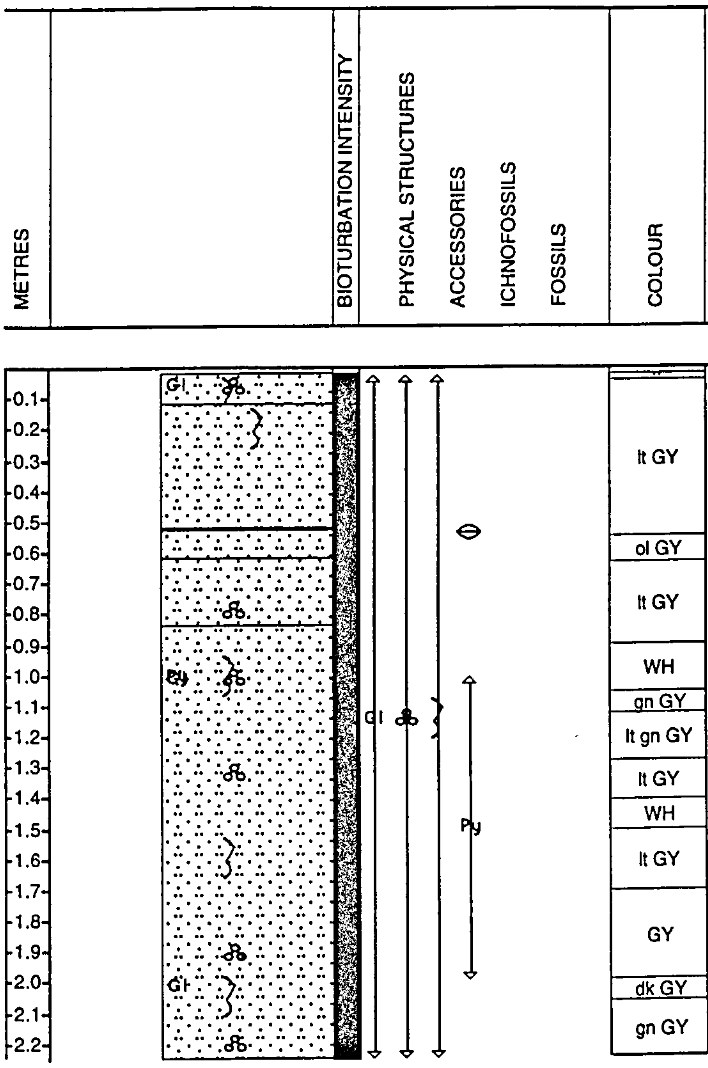
Site 10, W Campbell Plateau
53°20.02 S, 169°15.05 E, W.D. 601 m



SO136-061GC

Date logged: October 28, 1995
Logged by: J.R.

Site 10, W Campbell Plateau
53°20.00 S, 169°14.96 E, W.D. 602 m



REMARKS

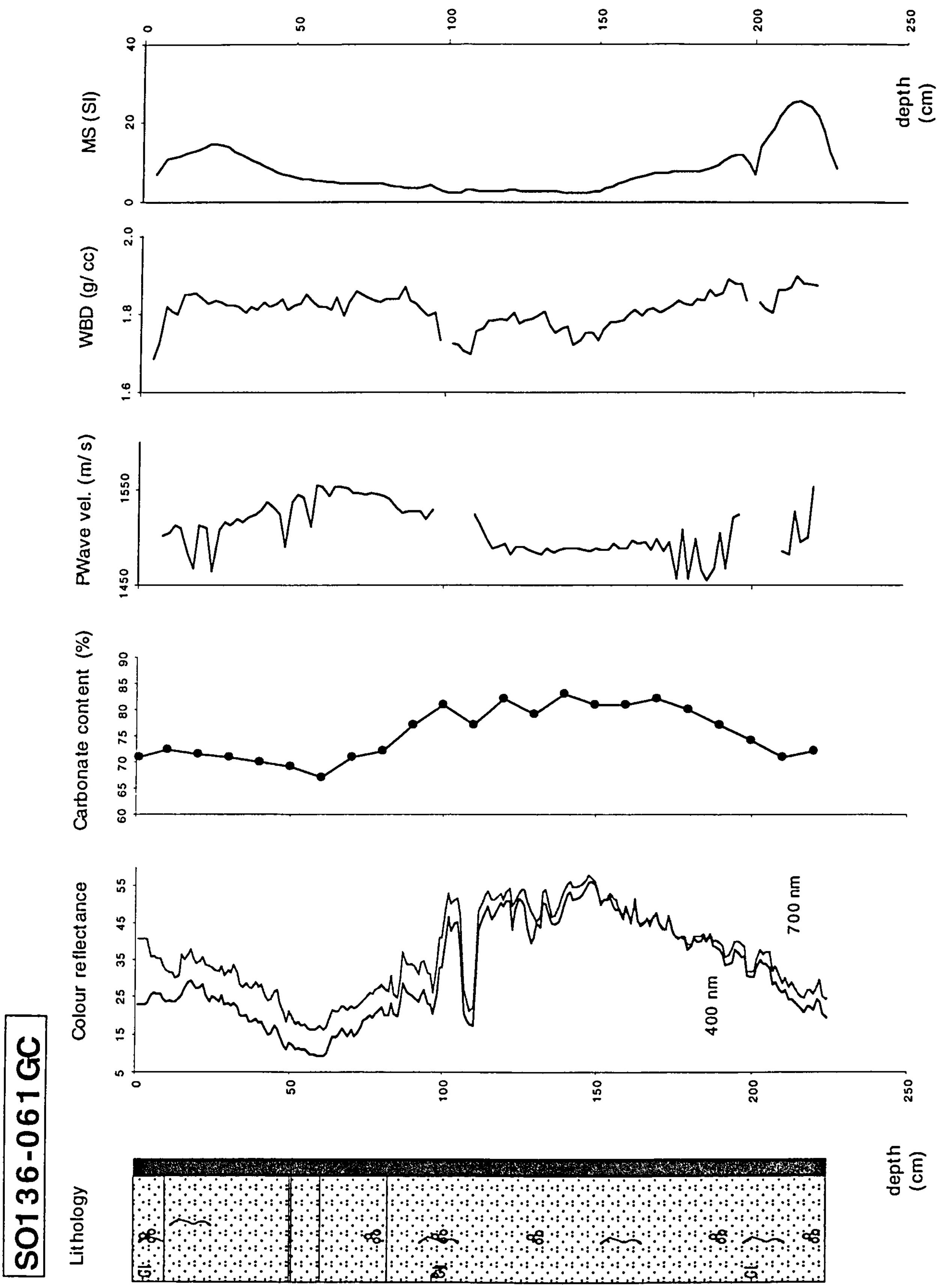
0.02-0.13: Coarse silty foram ooze with black grains (prob. glauconite).
0.13: Bioturbation style change.
0.13-0.55: Coarse silty foram ooze with black grains (prob. glauconite).
Flattened burrows due to compaction
0.52-0.53: Shelly layer.
0.55-0.62: Fine sandy foram ooze of olive gray colour.
0.62: Burrowed boundary and colour boundary.
0.62-1.00: Coarse silty foram ooze.
0.84: Burrowed boundary
Colour 0.02-0.045: N8/ (white)
0.045-0.55: 5Y 7/5 (light gray)
0.55-0.62: 5Y 4/2 (olive gray)
0.62-0.84: 5Y 7/2 (light gray)
0.84-1.00: Transition from 5Y 7/1 (light gray) to 5Y 8/1 (white).

Fine sand throughout entire core (forams make up the fine sand fraction).
Glauconite grains throughout entire core.

1.00-1.05: Silty foram ooze. Forams make up the fine sand fraction.
1.05-1.12: Fine sandy foram ooze, water rich/saturated layer.
1.12-2.00: Silty foram ooze. Forams make up the sand fraction.
Black grains throughout entire core (prob. glauconite).
Pyrite streaks to be found throughout.
Colours: 1.00-1.05: N8/ (white)
1.05-1.27/1.28: 10Y 6/1 (greenish gray) and 10Y 8/1 (light greenish gray).
1.27/1.28-1.35/1.41 (inclined): N7/ (light gray).
1.41-1.51: N8/ (white).
1.51-1.57: N7/ (light gray).
1.57-2.00: Gradual darkening colour up to N6/ (gray).

2.00-2.25: Heavily mottled, silty foram ooze with black grains (glauconite).
Colour: 2.00-2.07: N6/ (dark gray)
2.07-2.25: 5GY 6/1 to 5GY 5/1 (geenish gray).

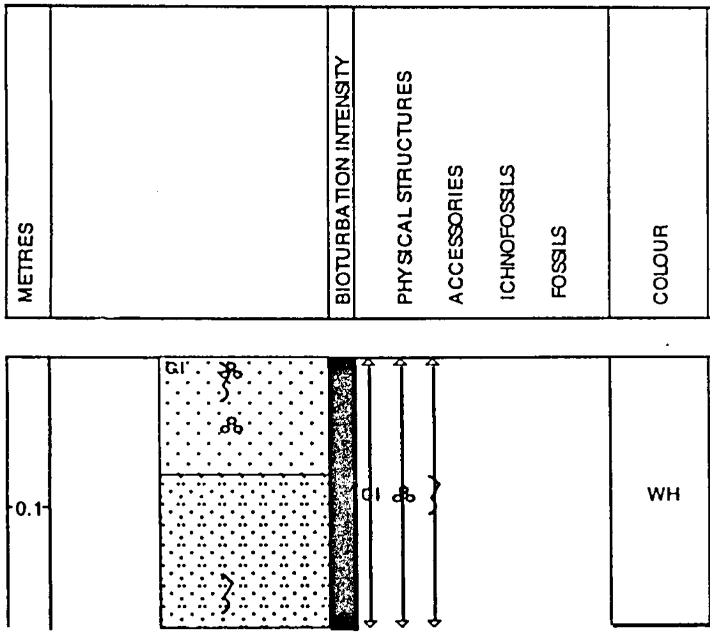
2.25: EOC.


SO136-061GC
MS (SI)
WBD (g/cc)
PWave vel. (m/s)
Carbonate content (%)
Colour reflectance
Lithology
depth (cm)
700 nm
400 nm

SO136-068BX

Date logged: October 27, 1998
Logged by: J. R.

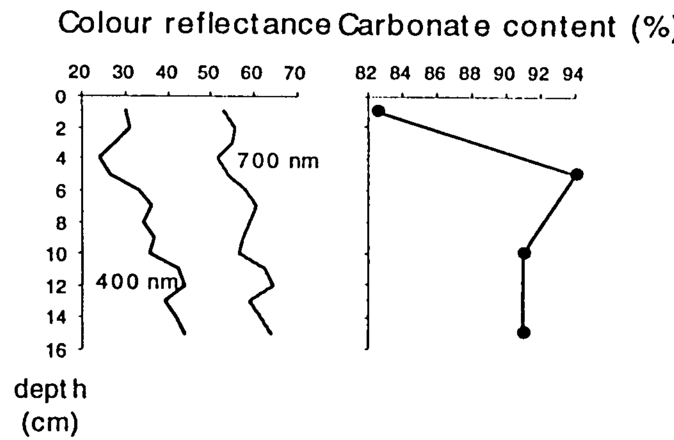
Site 11, W Campbell Plateau
54°05.01 S, 168°30.06 E, W.D. 981 m



REMARKS

0.00-0.08: Medium sandy foram ooze. Colour: 10YR 8/1 (white).
0.05-0.18: Colour change to N8/ (white).
0.08-0.18: Fine sandy foram ooze with burrows of light greenish gray (5GY 8/1) colour.
Glauconite occurs throughout entire core.

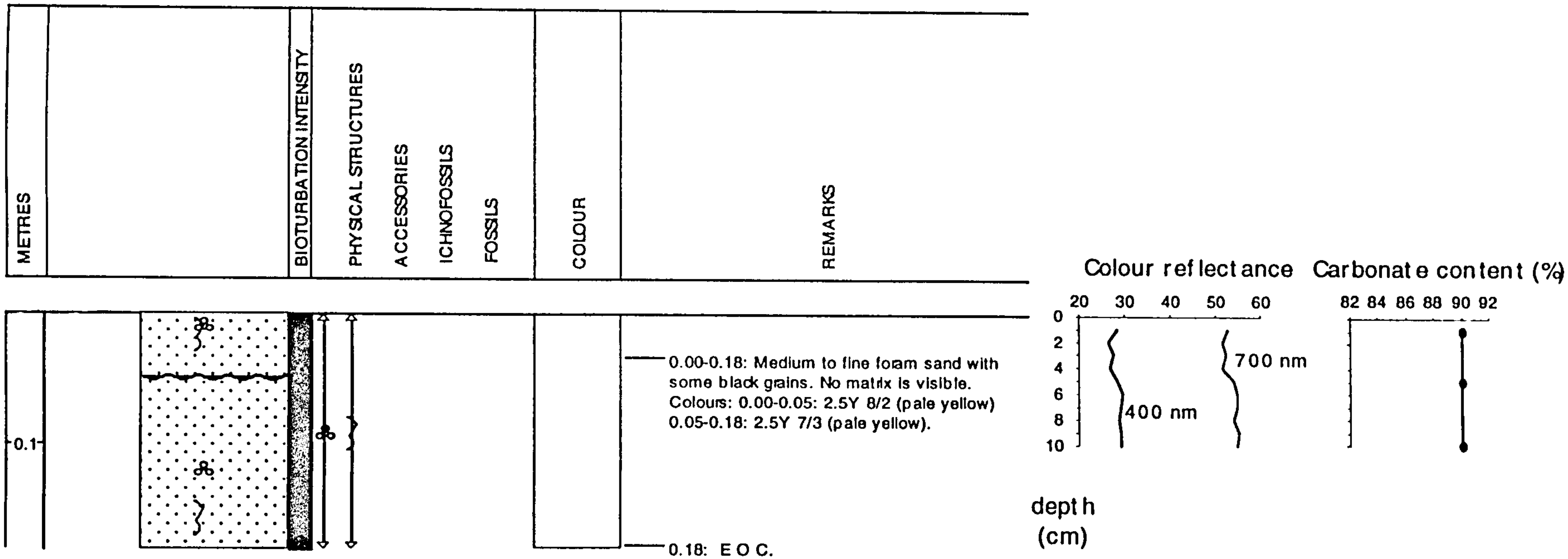
0.18: EOC.



SO136-082BX

Date logged: October 28, 1998
Logged by: J. R.

Site 13, W Campbell Plateau
55°20.07 S, 166°39.96 E, W.D. 1681 m

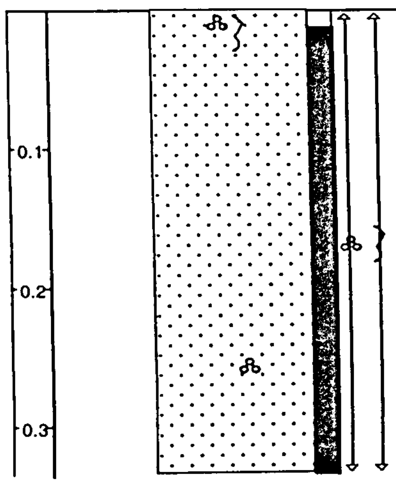


SO136-098BX

Date logged: October 30, 1998
Logged by: J. R.

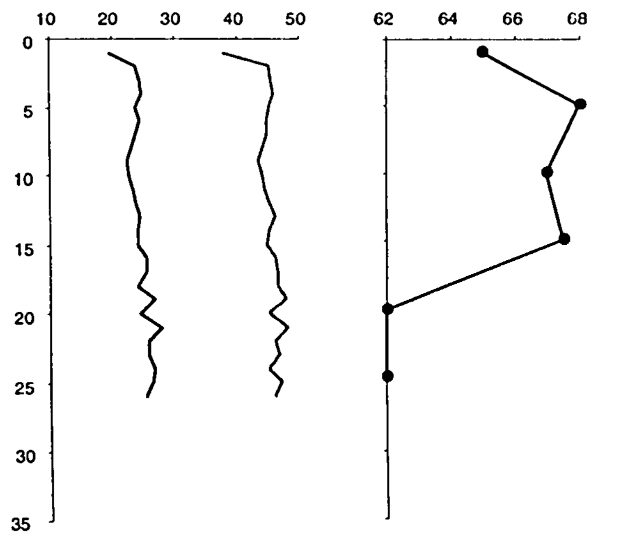
Site 16, W Campbell Plateau
55°43.89 S, 165°06.54 E, W.D. 4163 m

METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ACCESSORIES	ICHNOFOSSILS	FOSSILS	COLOUR	REMARKS



0.00-0.335: Fine foram sand with some black grains (prob. glauconite or manganese). Colour changes from 2.5Y 8/1 (white) to 2.5Y 8/3 (pale yellow).
0.00-0.01: Layer of "recently" transported sand.
0.01-0.335: Mottled area, no sedimentary structures are left.
0.20-0.30: Black streaks occur, colour: 2.5Y 5/1 (gray).

0.335: EOC.

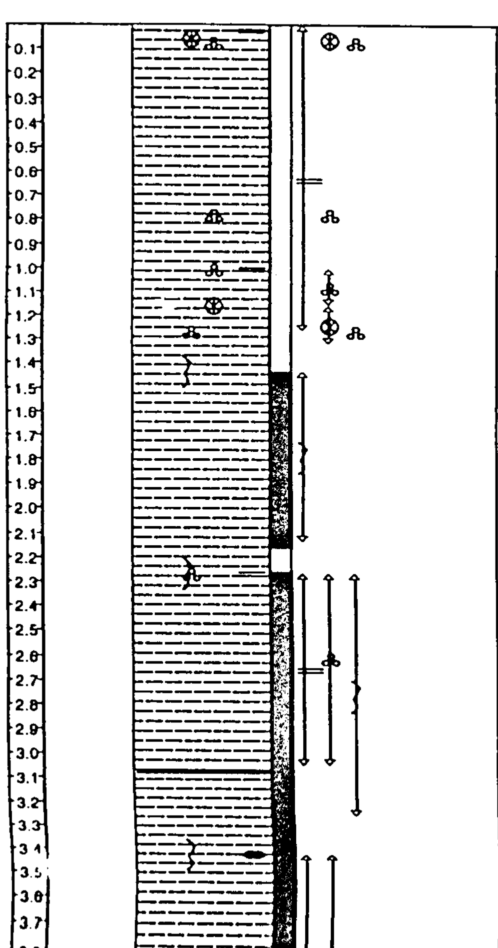


SO136-100GC

Date logged: October 31, 1998
Logged by: J. R. / G. v. d. L.

Site 17, Emerald Basin
56°27.52 S, 162°36.18 E, W.D. 5009 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | REMARKS



0.00-1.00: Finely to very finely laminated foram bearing siliceous to very siliceous ooze (Prob. diatom ooze, poss. diatoms), paper like lamination.
Especially the gray parts contain some forams and black grains.
Colours: 0.00-0.07: 10YR 5/6 (yellowish brown)
0.07-0.11: 2.5Y 6/1 (gray)
0.11-0.77: Transition from 10YR 5/6 (yellowish brown), over 10YR 6/4 (light yellowish brown) to 10YR 6/6 (brownish yellow)
0.77-0.79: 2.5Y 6/1 (gray)
0.79-0.82: 10Yr 6/3 (pale brown), very fine lamination
0.82-0.88: 2.5Y 6/1 (gray)
0.88-0.90: 10YR 4/3 (brown) to 10YR 3/3 (dark brown)
0.90-0.97: 10YR 7/1 (light gray) to 10YR 5/3 (brown)
0.97-1.03: 2.5Y 6/1 (gray), forams are visible and black grains, angular

1.03-1.15: Foram bearing ooze with to siltsized forams and black angular grains.
Colours: 1.03-1.04: 5Y 5/2 (olive gray).
1.04-1.15: 5Y 6/1 (gray).

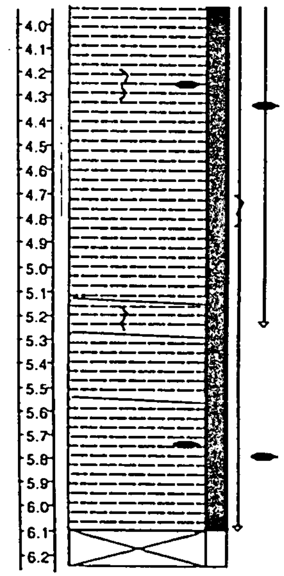
1.15-1.26: Siliceous to diatom ooze, paper-like foliated, diatom-mats ("toilet paper"), colour: 5Y 8/1 (white).

1.26-1.86: Foram bearing siliceous to very siliceous ooze.
1.26-1.31: Relatively foram rich, colour: 5Y 6/1 (gray)
1.31-1.39: No diatom mats, colour: 5Y 8/1 (white)
1.39-1.42: Some diatom mats, colour: 5Y 5/1 (gray)
1.42-1.43: No diatom mats, colour: 5Y 5/1 /gray)
1.42-1.86: Some diatom mats,
1.42-1.71: Very fine lamination, colour: 5Y 5/1 (gray)
1.71-1.73: Colour: 5Y 4/3 (olive)
1.73-1.86: Colour: 5YR 4/2 (dark reddish gray).

1.86-2.14: Almost pure clay, colour: 5Y 5/2 (olive).
2.14-2.26: Very fine laminated, foram bearing, siliceous to very siliceous ooze (diatoms and radiolarians). Colour: 5Y 4/1 (dark gray) to 5Y 4/2 (olive gray).

2.26-3.07: Foram bearing siliceous to very siliceous ooze, with angular black grains, laminated with individual burrows.
Colours: 2.26-3.07: mixture/lamination of 5Y 5/1 (gray), 5Y 4/3 (olive) & 5YR 4/2 (dark reddish gray (also surrounded by burrows).

3.07-3.42: (Hemi) (pelagic) clay without forams, colour: 5Y 5/2 (olive).



3.42-5.26: Hemi pelagic clay, heavily mottled, with black pyrite streks, without forams, colour: 5Y 4/2 (olive gray).
Colour of the mottles is 5Y 2.5/1 (black).
Pyrite occurs in : 3.63-3.70 (vaguely), 3.96-4.03, 4.28-44.35, 4.42-4.52, 4.59-4.64, 4.71-4.78, 4.94-5.07.

5.16-5.26: Fault/sliding horizon marked by black a line (pyrite).

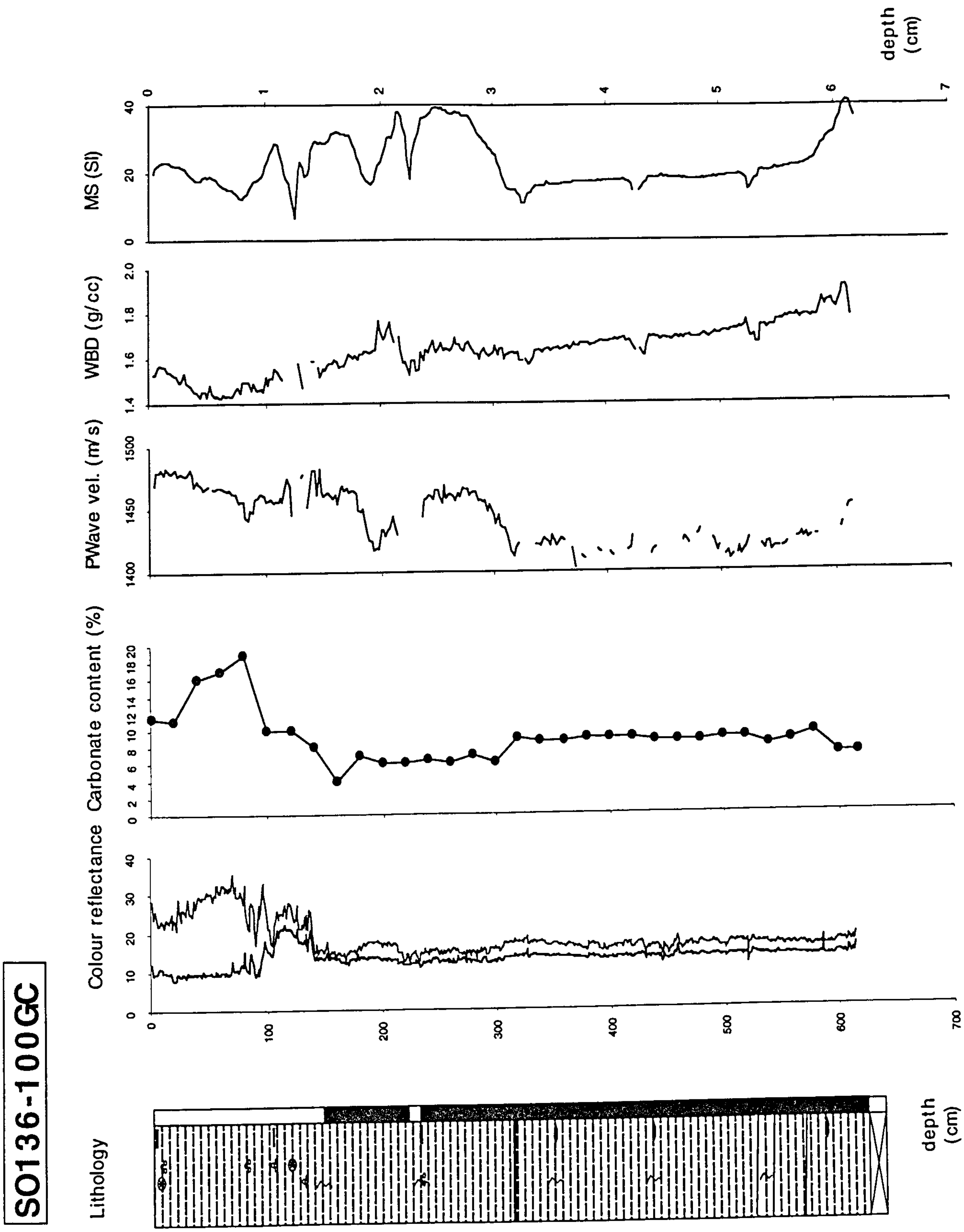
5.26-5.31: Fault/sliding horizon, displacement, marked by black pyrite zone.

5.50-5.65: Fault/sliding horizon, displacement, no lamination and mottling detectable.

5.26-6.26: Hemi pelagic clay with mottles and black pyrite horizons, colour: 5Y 5/2 (olive gray), colour of mottles: 5Y 2.5/1 (black).

6.12: EOC.

6.12-6.26: Void, cause of core-catcher.

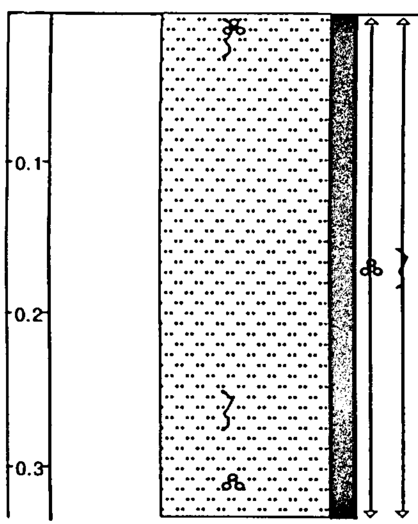

SO136-100GC
Lithology
Colour reflectance
Carbonate content (%)
PWave vel. (m/s)
WBD (g/cc)
MS (SI)
depth (cm)
depth (cm)
0 100 200 300 400 500 600 700
0 1 2 3 4 5 6 7

SO136-110BX

Date logged: November 1, 1998
Logged by: S.R. / J.R.

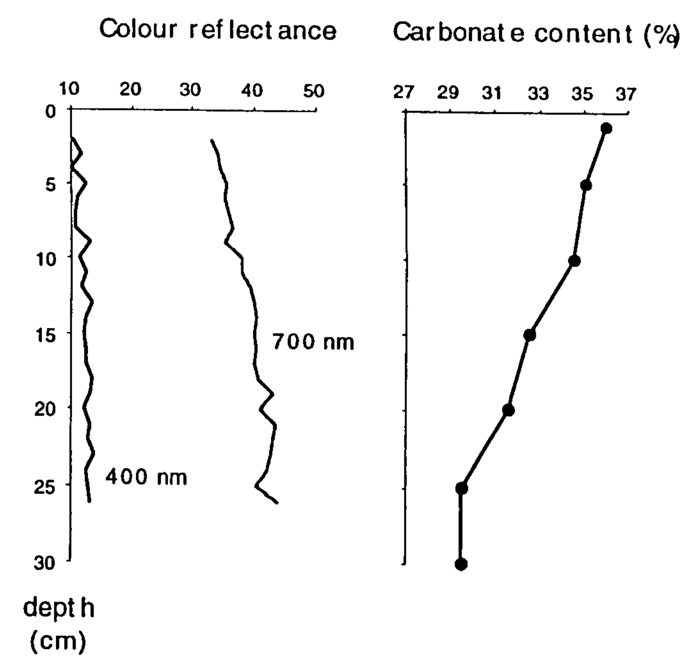
Site 20, Emerald Basin
56°40.87 S, 160°14.86 E, W.D. 3907 m

METRES		BIOTURBATION INTENSITY	ACCESSORIES	ICHNOFOSSILS	FOSSILS	REMARKS



0.00-0.335: Fine silty, foram bearing diatom-radiolarian-ooze.
Burrows at 0.06 & 0.21 cm,
0.10-0.19: Black silt grains.
Colour: 0.00-0.21: 2.5Y 6/6 (olive yellow),
0.21-0.335: 2.5Y 7/6 (yellow).

0.335: E O C.



SO136-111GC

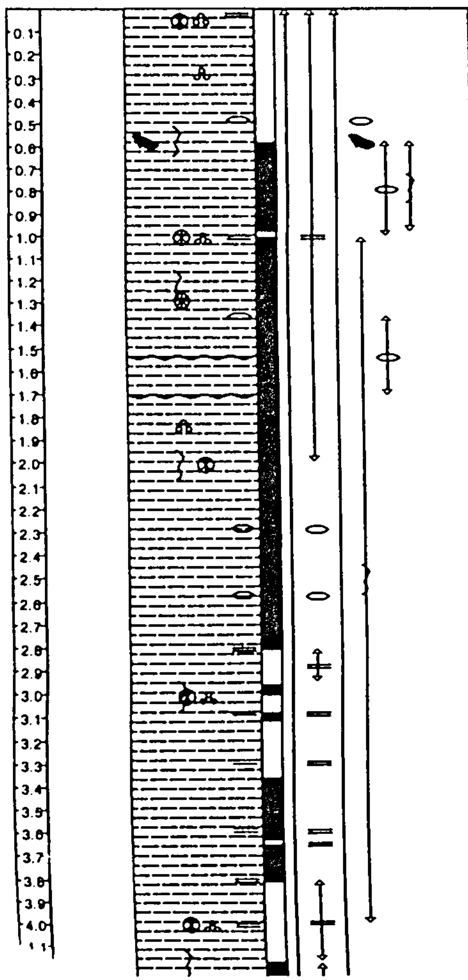
Date logged: November 1, 1998

Logged by: J.R.

Site 20, Emerald Basin

56°40.86 S, 160°14.49 E, W.D. 3912 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | COLOUR | REMARKS



0.00-9.87: Foram bearing siliceous diatom-ooze to very siliceous clay with varying amounts of vfs - silty pelagic forams and black angular grains throughout entire core.

0.00-0.52: Finely laminated, colour: From 10YR 7/2 (light gray) to 10YR 8/3 (very pale brown).
0.47-0.48: Burrow filled with diatom ooze.

0.56: Dropstone (4mm).
0.52-0.57: Thin bioturbated layer, colour: 2.5Y 8/1 (white).

0.57-1.00: Foram bearing siliceous diatom ooze to very siliceous clay, pelagic forams and black angular very fine sand grains.
Large burrows: Type 1.: Large and round (2.5cm I.d.)
Type 2.: Thin flat ones, 5 cm of length (chondrites).
Finely laminated throughout.
Colour changes from 2.5Y 6/2 (light brownish gray) over 2.5Y 7/3 (pale yellow) to 2.5Y 4/3 (olive brown).
0.98: Colour boundary. Colour changes to white (2.5Y 8/1).

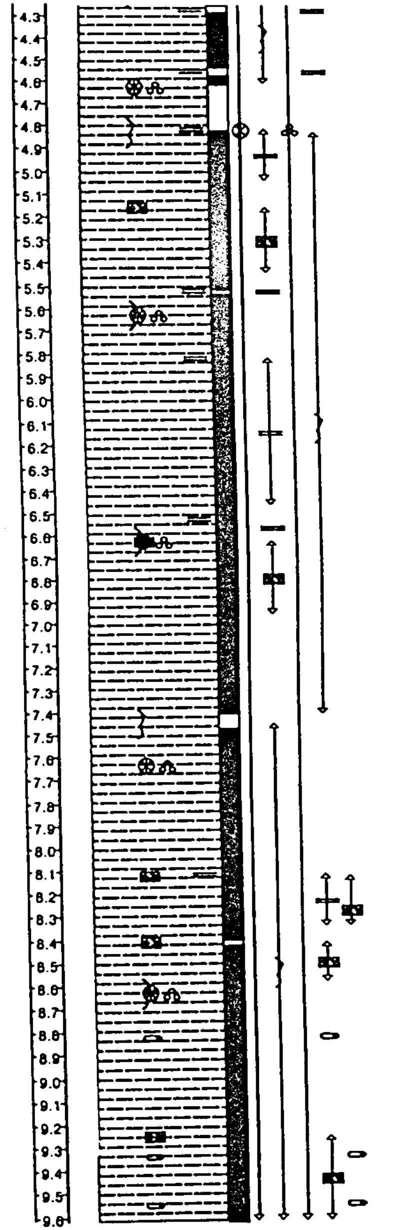
1.00-1.29: Fine chondrites.
Colours: 1.00-1.15: 2.5Y 7/2 to 2.5Y 3/2 (very dark gr. brown).
1.14-1.15: Dark interval, colour 2.5Y 3/2 (very dark gr. brown).
1.15-1.29: Boundaries and intervals more disturbed due to changes in colour and bioturbation patterns, colour: from 2.5Y 7/2 (light gray) to 2.5Y 4/3 (olive brown).
1.29-1.31, 1.32-1.35: Datom mats rich intervals, strongly bioturbated.
1.35-1.54: Large burrows & large halos.
Colour: 1.32-1.54: 2.5Y 7/3 (pale yellow).

1.54: Lithologic boundary.

1.71: Lithologic boundary.

1.54-1.71: Large burrows and small burrows, fine lamination, colour: 2.5Y 5/3 (light olive brown) to 2.5Y 3/3 (dark olive brown).
1.71-2.00: Small chondrites (0.5 cm I. d.), fine laminae.
Colour: 2.5Y 8/2 (pale yellow)

2.00-2.45: Small chondites and large burrows with big halos, colour changing from 2.5Y 8/2 to 2.5Y 7/2 (light gray).
2.21 & 2.40: Black layers.
2.45: Lithologic and colour boundary.



2.45-2.805: 2.5Y 8/2 (pale yellow).
2.805-2.955: Finely laminated interval (1-3mm): black layers (2.5Y 8/1) and light intervals.
2.955-3.00: Colour: 2.5Y 8/2 (pale yellow).

Fine lamination of lighter and darker intervals:
1.: Small clay-rich layers, not affected by bioturbation, 2.5Y 8/2 (pale yellow), 2.: 2.5Y 7/2 (light gray), 3.: Finely laminated, 2.5Y 5/2 (grayish brown), 4.: 2.5Y 8/3 (pale yellow).

Colours: 4.00-4.17: 2.5Y 6/1 (gray) and 2.5Y 5/1 (black) and variations in between.
4.17-4.235: 2.5Y 8/2 (pale yellow)
4.235-4.265: 2.5Y 6/1 (gray)
4.265-4.535: 2.5Y 8/1 (white)
4.535-4.545: 2.5Y 6/1 (gray)
4.545-4.67: 2.5Y 8/1 (white).
Black and gray units are finely laminated.
Pale yellow and white units bear chondites.

4.67-4.73: 2.5Y 7/1 (light gray)
4.73-4.82: 2.5Y 8/1 (white)
4.82-5.03: Yellow with black laminae(2.5Y 2.5/1) and light brownish gray laminae (2.5Y 6/2)
5.03-5.51: 5GY 6/1 (greenish gray)
5.51-5.52: 2.5Y 4/1 (dark gray)
5.52-5.815: Paper mat features with chondrites in between all thin layers. Colour: 2.5Y 8/1 (white).

5.815-6.62: Colours vary between 2.5Y 8/1 (white), 2.5Y 2.5/1 (black), 2.5Y 7/1 (light gray), 2.5Y 8/3 & 2.5Y 7/3 (pale yellow).
Variations in clay content, pelagic forams content and black angular silt sized grains (some wax-like= qtz?)

6.62-7.61: Paperlike feature disappears, sediment gets grayer up to 7.15, then back to white.

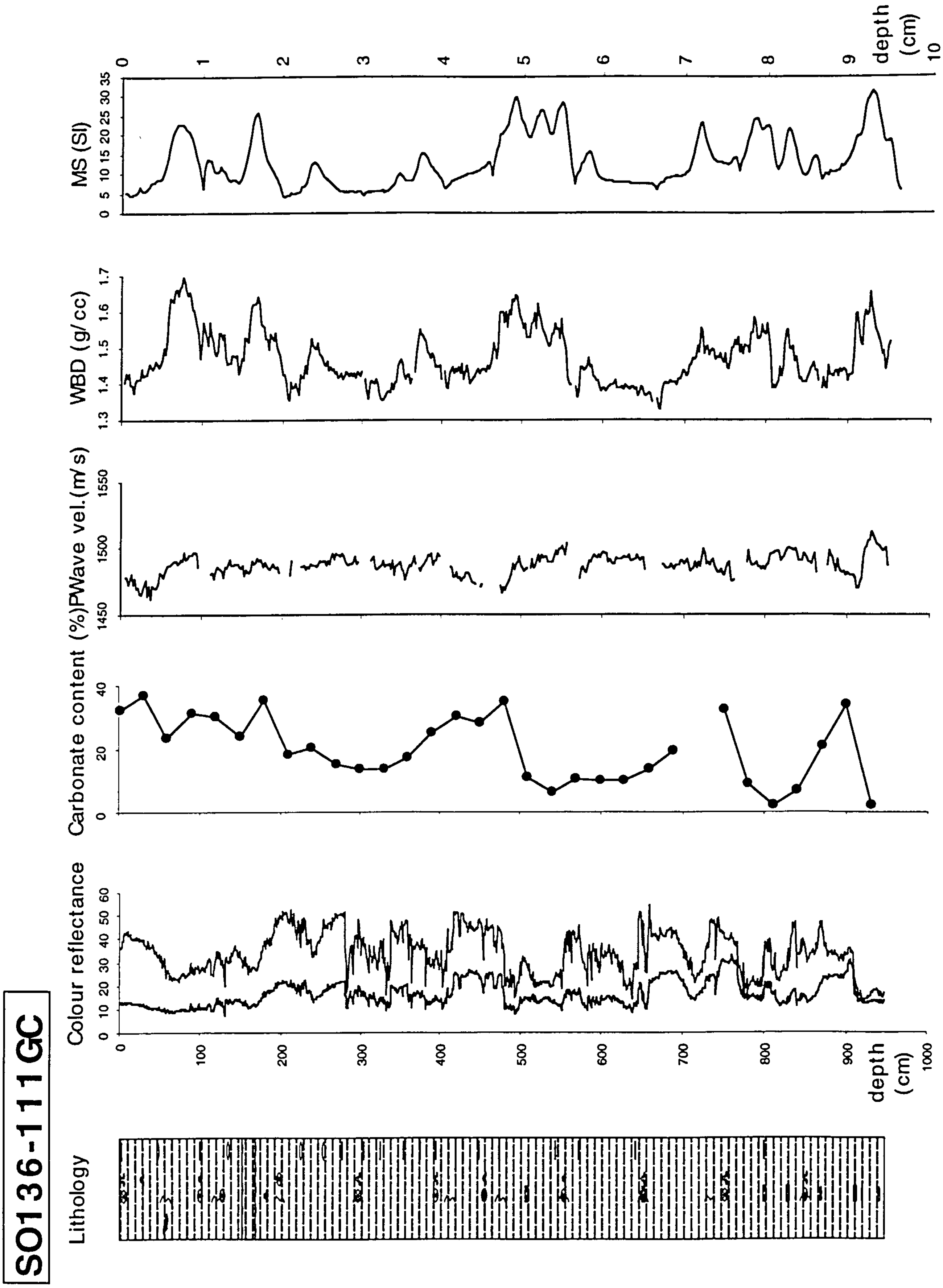
Colours:
6.62-7.41: Colour cycle: Gradual transition from white (2.5Y 8/1) over light gray (2.5Y 7/2) to glauconite rich greenish gray (5GY 6/1) sediments. Then over a light greenish gray (5GY 8/1) back to beginning level, white (2.5Y 8/1).

7.40-7.41: Black interval, colour 2.5Y 2.5/1 (black).
7.41-7.62: 2.5Y 8/1 (white).

7.62-8.01: Alternation of colours: White (N8/1), light greenish gray (5GY 7/1) and greenish gray (5GY 6/1 & 5GY 5/1).
8.01-8.10: Datom mat rich interval, colour: 2.5Y 8/2 (pale yellow).
8.10-8.34: Alternation of colours: 2.5Y 6/3, 2.5Y 7/3 & 2.5Y 7/2.
Chondrites are clearly visible.
8.34-8.57: 2.5Y 8/3 (pale yellow)
8.40: Dark grayish brown interval (2.5Y 4/2)
8.57-8.65: 2.5Y 7/2 (light gray).

8.65-9.61: Forams become coarser, from coarse silt/very fine sand to fine sand.
Bioturbation, mottling becomes stronger (Planulites).
the greenish units are glauconite rich.
Additionally black, angular, coarse sand to fine sand grains.
Colours: 8.65-9.02: Light greenish gray (2.5Y 8/3 & 2.5Y 8/1).
9.02-9.11: N8/ (white)
9.11-9.61 Greenish gray (5GY 5/1 & 5GY 6/1).

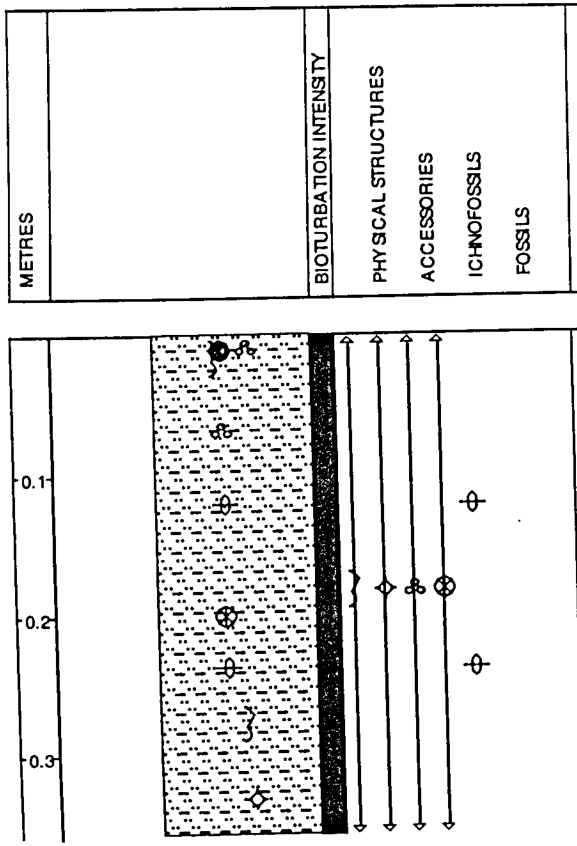
9.61: EOC


SO136-111GC
Lithology
Colour reflectance
Carbonate content (%)
PWave vel.(m/s)
WBD (g/cc)
MS (SI)
depth (cm)

SO136-116BX

Date logged: November 3, 1998
Logged by: J. R.

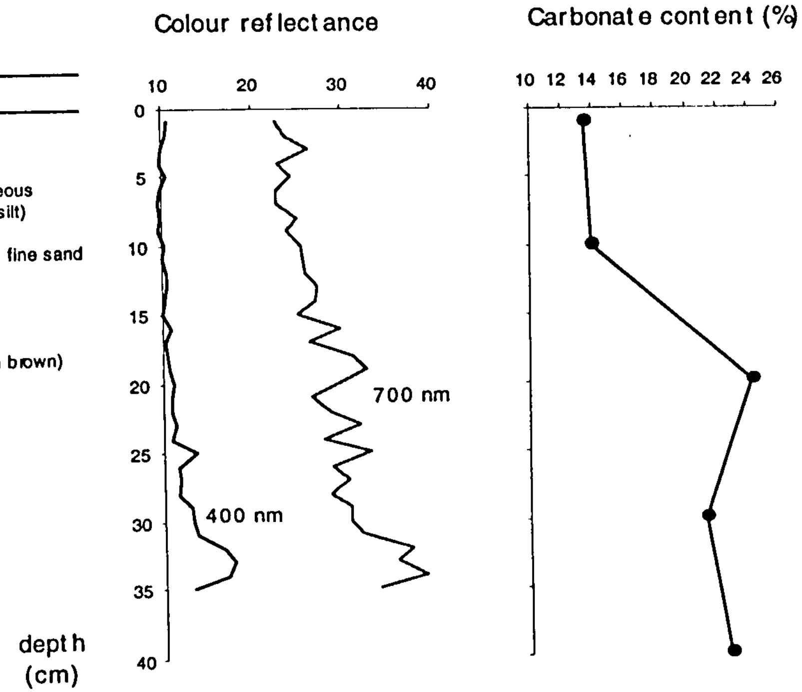
Site 21, Emerald Basin
55°40.03 S, 156°25.00 E, W.D. 4462 m



REMARKS

0.00-0.36: Foram bearing diatom/radiolarian siliceous ooze with black angular and well sorted (coarse silt) clasts.
Pelagic forams well sorted, grain size: From very fine sand to coarse silt.
0.00-0.065: Diatom mat filled burrow.
0.22-0.23: Diatom mat filled burrow.
0.34: Bioturbated boundary.
Colours: 0.00-0.34: Mixture of 2.5Y 5/2 (grayish brown) and 2.5Y 7/4 (pale yellow).
0.34-0.36: 2.5Y 8/1 (white).

0.36: EOC.

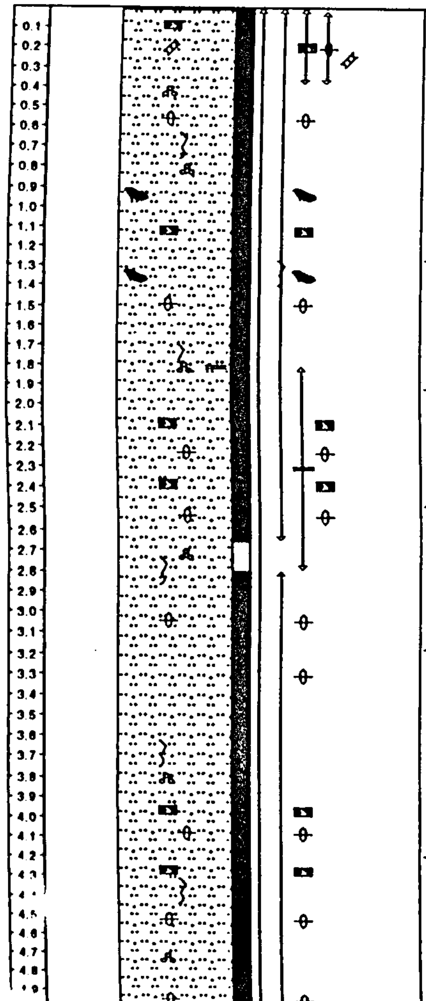


SO136-117GC

Date logged: November 3, 1998
Logged by: J. R. / G. v. d. L.

Site 21, Emerald Basin
55°40.00 S, 159°25.06 E, W.D. 4460 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | REMARKS



REMARKS

Foam bearing diatom/radiolarian ooze or siliceous ooze with changing content of terrigenous input throughout entire core.
Vague parallel lamination visible throughout core.

0.00-0.80: Grain size cycle: 0.00-0.38: Fining down, 0.38-0.44: Finest unit, 0.44-0.60: coarsening down, 0.60-0.80: Foams make up medium sand fraction.
0.20-0.32: Several algal mats.
Colours: 0.015-0.38: Gradual transition from 2.5Y 5/4 (light olive brown) to 2.5Y 6/4 (light yellowish brown), small unit of light brownish grey (2.5Y 6/2) sediments (0.32-0.335).
0.38-0.49: 2.5Y 5/3 (light olive brown).
0.49-0.80: 2.5Y 6/4 (light yellowish brown) with a thin layer (0.58-0.60) of light olive brown (2.5Y 5/3) sediments.

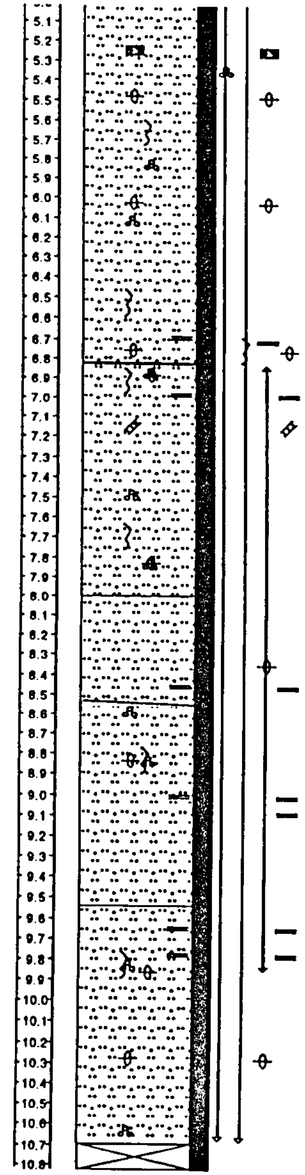
0.80-0.82: Very fine sand, 2.5Y 7/2 (light grey).
0.82-1.02: Very fine sand, transition from light olive brown (2.5Y 5/4) to very dark grayish brown (2.5Y 3/2), dropstone (0.5cm) at 0.90m.
1.02-1.80: Fine sand.
Colours: 1.02-1.20: 2.5Y 6/2 (light brownish grey) to 2.5Y 4/3 (olive brown).
1.20-2.48: 2.5Y 6/3 (light yellowish brown) grading into 2.5Y 6/2 (light brownish grey) with a very dark grayish brown (2.5Y 3/2) streak at 1.93m and a vague layer of grayish brown colour (2.5Y 5/2) at 2.26-2.27m.
1.30: Dropstone (1cm).

Fine sand throughout rest of the core, visible lamination.

2.48-2.50: Clearly laminated unit, colour: 2.5Y 5/2 (grayish brown).
2.50-2.66: 2.5Y 7/2 (light grey).
2.66-2.80: Clearly laminated sheets with changing colour from 2.5Y 7/2 (light grey) to 2.5Y 4/2 (dark grayish brown).

2.80-3.80: All boundaries bioturbated and heavily mottled, with small lithologic changes. The burrows are filled with light yellow (2.5Y 8/2) material.
Colours: 2.80-2.85: 2.5Y 7/2 (light grey).
2.85-2.97: 2.5Y 5/2 (grayish brown).
2.97-3.06: 2.5Y 4/1 (dark grey).
3.06-3.46: Transition from 2.5Y 7/3 (pale yellow) to 2.5Y 6/3 (light yellowish brown).
3.46-3.60: 2.5Y 5/2 (grayish brown).
3.60-3.80: Transition from 2.5Y 7/3 (pale yellow) to 2.5Y 7/2 (light grey) with dark patches of dark grayish brown (2.5Y 4/2) colour.

3.80-6.82: All boundaries (colour and lithologic) vaguely bioturbated Specific burrows thoughout are Chondritic types, all subhorizontal, 1cm of length. Burrows are filled with pale yellow (2.5Y 8/2) material.
Colours: 3.80-4.27: Change from 2.5Y 8/3 (pale yellow) over 2.5Y 7/2 (light grey) to 2.5Y 6/2 (light brownish grey).
4.27-4.36: 2.5Y 6/3 (light yellowish brown).
4.36-4.42: 2.5Y 7/2 (light grey).
4.42-4.46: 2.5Y 5/2 (grayish brown) and 2.5Y 3/2 (very dark grayish brown).



4.46-4.49: 2.5Y 8/2 (white).
4.49-4.61: 2.5Y 5/2 (grayish brown) to 2.5Y 6/3 (light yellowish brown).
4.61-4.80: 2.5Y 7/2 (light grey) to 2.5Y 5/2 (grayish brown).

4.80-5.08: 2.5Y 5/1 (grey) and 2.5Y 6/3 (light yellowish brown) with 2.5Y 8/2 (pale yellow) burrow infills.
5.08-5.38: 2.5Y 6/2 (light brownish grey) to 2.5Y 7/2 (light grey).
5.38-5.52: 2.5y 6/3 (light yellowish brown) with several burrows, 2.5Y 7/2 (light grey).
5.52-5.68: 2.5Y 5/2 (grayish brown) to 2.5Y 4/2 (dark grayish brown).
5.68-5.82: 2.5Y 5/2 (grayish brown) to 2.5Y 5/3 (light olive brown).

5.82-6.04: 2.5Y 7/3 (pale yellow) with a large burrow of light grey (2.5Y 7/1) colour.
6.04-6.25: Gradual lightening: 2.5Y 5/2 (grayish brown), 2.5Y 6/2 (light brownish grey), 2.5Y 6/3 (light yellowish brown).
6.25-6.58: 2.5Y 4/2 (dark grayish brown).
6.14-6.58: Bioturbation increases and becomes clearer. Burrows of light yellowish brown colour (2.5Y 6/3).
6.58-6.69: Transition from 2.5Y 6/3 (light yellowish brown) to 2.5Y 7/3 (pale yellow).
6.69-6.82: Colour change from 2.5Y 6/3 (light yellowish brown) to 2.5Y 8/2 (pale yellow).

Laminae are present, but probably of secondary origin.

6.82-7.82: Grain size cycle: 6.82-7.14: Fine sand, colour changes from 2.5Y 7/3 (pale yellow) to 2.5Y 6/3 (light yellowish brown).
7.14-7.21: clayey unit with several diatom mats of 2.5Y 8/2 (pale yellow) to 2.5Y 5/2 (grayish brown) colour.
7.21-7.32: Very fine sand, gradual colour change from 2.5Y 8/2 (pale yellow) to 2.5Y 7/2 (light grey). Several diatom-filled burrows.
7.32-8.00: Fine sand, colours change gradually from 2.5 7/2 over 2.5 5/1 (grey), 2.5Y 5/2 (grayish brown), 2.5Y 6/2 (light grayish brown), and 2.5Y 6/3 (light yellowish brown) to 2.5Y 5/1 (grey). Burrows are throughout of pale yellow colour (2.5Y 8/2).

8.01: Straight line: secundary laminal

8.10-8.27: Lamination of light grey (2.5Y 7/2), dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2).
8.27-8.53/8.57: Gradual transition from 2.5Y 6/3 (light yellowish brown) to 2.5Y 4/1 (dark grey).
8.53/8.57-8.82: Transition from 2.5Y 5/3 (light olive brown) to 2.5y 7/3 (pale yellow).

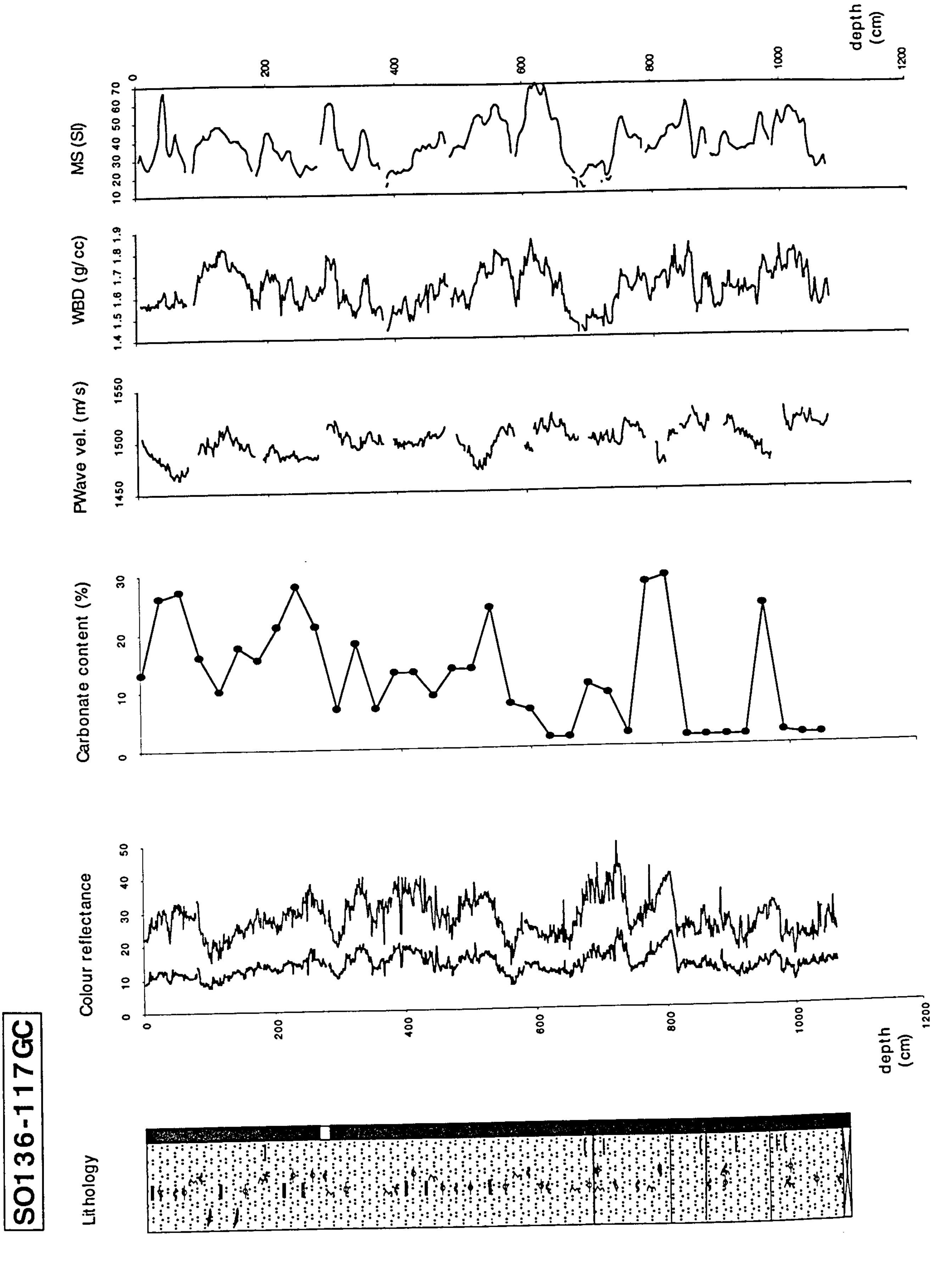
Fine laminae cross cut burrows, therefore secondary diagenetic horizons of very dark grayish brown colour (2.5Y 3/2).

8.82-8.98: 2.5Y 6/2 (light brownish grey) to 2.5Y 7/3 (pale yellow).
8.98-9.125: 2.5Y 5/2 (grayish brown).
9.125-9.55: Transition from 2.5Y 5/3 (light olive brown) to 2.5Y 7/2 (light grey).
9.55: Diagenetic horizon or clay-rich layer, but bioturbation goes through this time.
9.55-9.59: Clay-rich interval of 2.5Y 4/2 (dark grayish brown) colour.
9.59.9.82: Mixture of 2.5Y 6/2 (light brownish grey) and 2.5Y 4/2 (dark grayish brown).

9.82-10.69: No clear laminations present. Burrows are filled with pale yellow material (2.5y 8/3).
Colours: 9.82-9.97: 2.5Y 5/2 (grayish brown).
9.97-10.01: 2.5Y 5/2 (grayish brown) to 2.5y 3/2 (very dark grayish brown).
10.01-10.04: 2.5Y 6/2 (light brownish grey) to 2.5Y 4/2 (dark grayish brown).
10.04-10.27: 2.5Y 5/2 (grayish brown) to 2.5Y 5/1 (grey).
10.27-10.32: 2.5Y 6/2 (light brownish grey).
10.32-10.38: 2.5Y 5/1 (grey).
10.38-10.44: 2.5Y 6/3 (light yellowish brown).
10.44-10.48: 2.5Y 8/3 (pale yellow).
10.48-10.69: 2.5Y 5/1 (grey) to 2.5Y 7/3 (pale yellow).

10.69: EOC.

10.69-10.82: Void cause of core catcher

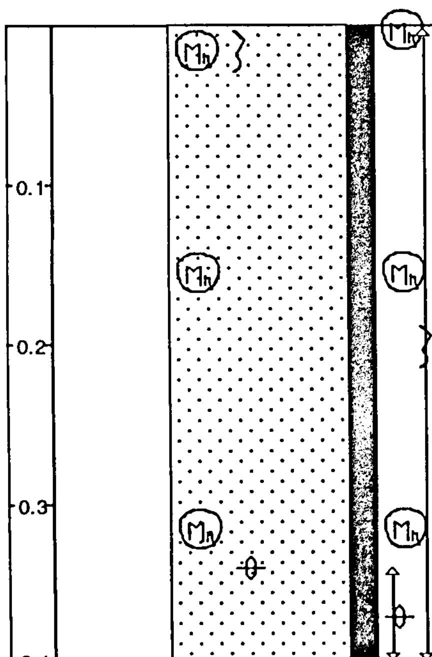

SO136-117GC
MS (SI)
WBD (g/cc)
PWave vel. (m/s)
Carbonate content (%)
Colour reflectance
Lithology
depth (cm)

SO136-123BX

Date logged: November 4, 1998
Logged by: J. R.

Site 23, South Tasman Rise
52°59.89 S, 151°08.23 E, W.D. 4196 m

METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ACCESSORIES	ICHNOFOSSILS	FOSSILS	COLOUR	REMARKS



lt ye BR

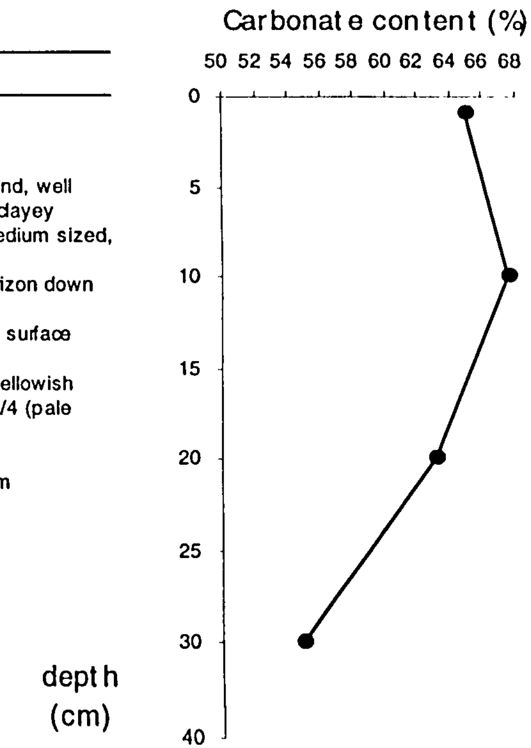
pal YE

0.00-0.40: Medium foraminiferal sand, well sorted, heavily bioturbated with a clayey (diatom?) matrix which includes medium sized, subrounded Mn grains.
(Stechkasten due to Mn nodule horizon down to bottom.)
Surface: Mn nodules sticking in the surface (half), colour: 2.5Y 2.5/1 (black).
Sediment colours: 2.5Y 6/4 (light yellowish brown) on top, grading into 2.5Y 7/4 (pale yellow) at bottom.
Burrows: 2.5Y 8/2 (pale yellow).
Size of Mn nodules: 0.11-0.18: 7cm
0.23-0.30: 7cm
0.35-0.42: 5cm

0.12-0.19: Mn nodule horizon.

0.33-0.38: Mn nodule horizon.

0.40: EOC.

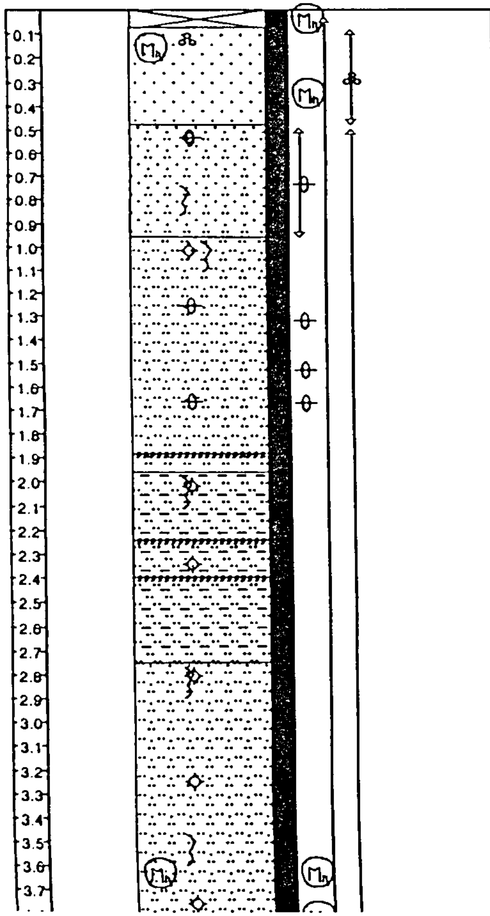


SO136-124GC

Date logged: November 4, 1998
Logged by: J. R. / H. N.

Site 23, South Tasman Rise
52°59.77 S, 151°08.14 E, W.D. 4199 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | COLOUR | REMARKS



Colour: vpl BR; BR; dk BR; lt ye BR; gy BR; vpl BR; BR; vpl BR; pal BR

0.00-0.08: Mn nodules, which are very well sorted, as well as the subrounding qtz-grains.

0.08-0.96: Coarsening upwards cycle. Top : Calcareous clay (soft), base: Mn-rich siliceous clay (firm). The clay content increases downcore.
Foams are present at top, vanish at base.
0.32-0.36: Mn nodule.
Colours: 0.08-0.35: Gradual transition from 10YR 7/3 (very pale brown) to 10YR 5/3 (brown).
0.15: Vague colour boundary.
0.35: Colour changes from 10YR 5/3 (brown) to 10YR 4/3 (brown).
0.35-0.96: Gradual colour change from 10YR 4/3 (brown) to 10YR 3/3 (dark brown).

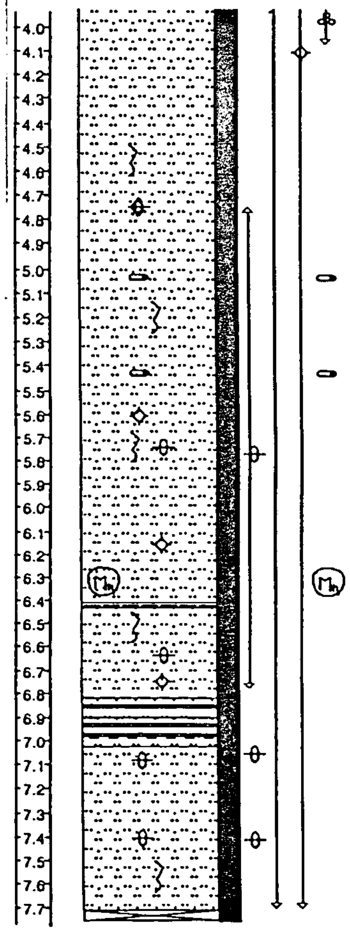
0.96-1.96: Mn-rich sandy (siliceous) clay of firm and stiff consistence with radiolarians and qtz grains (both very fine sandy to fine sandy), Mn grains (very fine sandy to fine sandy) as well as some granular and pebble sized Mn .
Colour. 0.96-1.89: 10YR 3/3 (dark brown).
The material of the burrow infills is from down below.

1.89-1.96: 10YR 6/4 (light yellowish brown).

1.96-2.75: Mn-rich, qtz and radiolarian bearing clay.
Fining downwards cycle from fine sand at top to very fine sand at base.
Some Mn granules are present throughout entire core.
Colours: 1.96-2.33: 10YR 6/4 (light yellowish brown).
2.33-2.52: 10YR %72 (grayish brown).
2.52-3.20: 10YR 7/3 (very pale brown).

2.71-2.75: Bottom compacted, semilithified clay, colour. 10YR 5/3 (brown).

2.75-3.75: Very firm, semi-lithified Mn-rich radiolarian (vfs) and qtz (vfs, well sorted) bearing clay. Relatively dark layers, relatively less foams.
3.62-3.69: Mn clast =top/crust.
Colours: 3.20-3.62: 10YR 7/3 (very pale brown).
3.62-3.84: 10YR 6/3 (pale brown)



Colour: pal YE; lt ye BR; ol BR; lt ye BR; lt ol BR; pal YE; lt ol BR; pal YE; lt ye BR; lt ye BR; lt ye BR GY; gy BR lt ol BR

Mn-rich , radiolarian and qtz bearing clay throughout rest of the core. Mn granules throughout entire core. Radiolarians and qtz make up the coarse silt fraction.
3.84-4.09: Clayey layer with foams.
Colours: 3.75-3.84: 10YR 6/3 (pale brown).
3.84-4.09: 2.5Y 7/3 (pale yellow).
4.09-4.75: Gradual transition from 2.5Y 6/2 (light yellowish brown) to 2.5Y 5/3 (light olive brown).

4.75-5.75: Very heavily bioturbated section. Burrows cross each other, Planulites, etc. in all directions.
Darker units content more Mn, lighter units more radiolarians and qtz.
All colours are mixed, throughout entire core section, mentioned are the dominant colours:
4.75-5.24: Gradual transition from 2.5Y 6/3 (light yellowish brown) to 2.5Y 8/2 (pale yellow).
5.24-5.43: 2.5Y 5/3 (light olive brown).
5.43-5.66: 2.5Y 7/3 (pale yellow).
5.66-5.96: 2.5Y 5/3 (light olive brown).

5.75-6.75: Strongly bioturbated, dominance of downhole burrowers.
The colour varies , dominant colours mentioned:
5.96-6.07: 2.5Y 7/3 (pale yellow).
6.07-6.84: 2.5Y 6/3 (light yellowish brown).
6.57-6.73: Long burrow.

6.19-6.21: Concentration of big radiolarians.

6.32-6.36: Mn nodule (5cm i.d.).

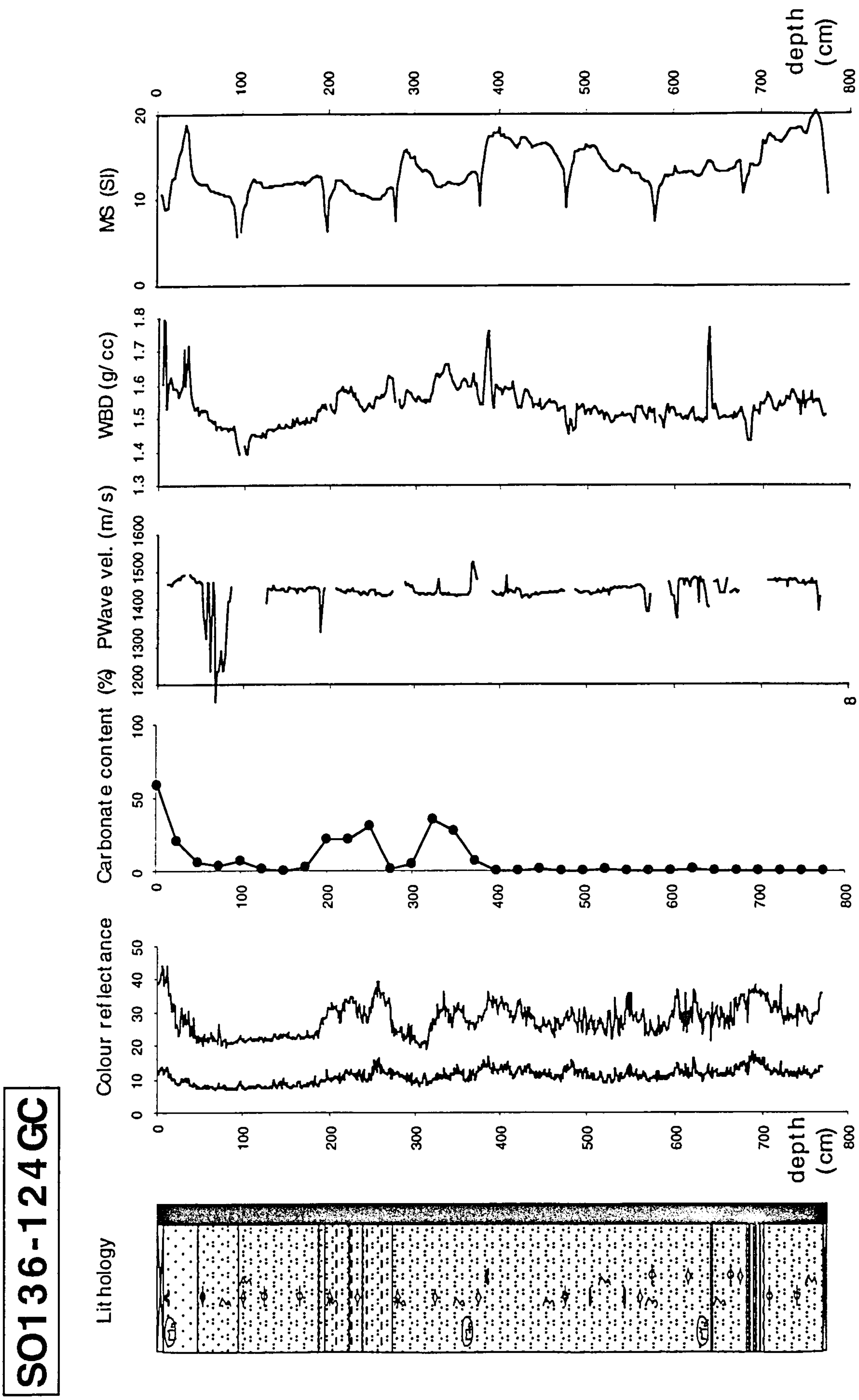
6.44-6.45: Pinky clay layer.

6.84-7.12: 7 very fine gray clay layers of diagenetic origin, wavy, same texture all over. Zoophycus structure layers in between all radiolarian bearing pink clays associated with it.

Colours:
6.84-7.12: Mixture of 2.5Y 6/3 (light yellowish brown) and 2.5Y 7/1 (gray).
7.12-7.77: Mixture of 2.5Y 5/2 (grayish brown) and 2.5Y 5/3 (light olive brown).

7.73: EOC.

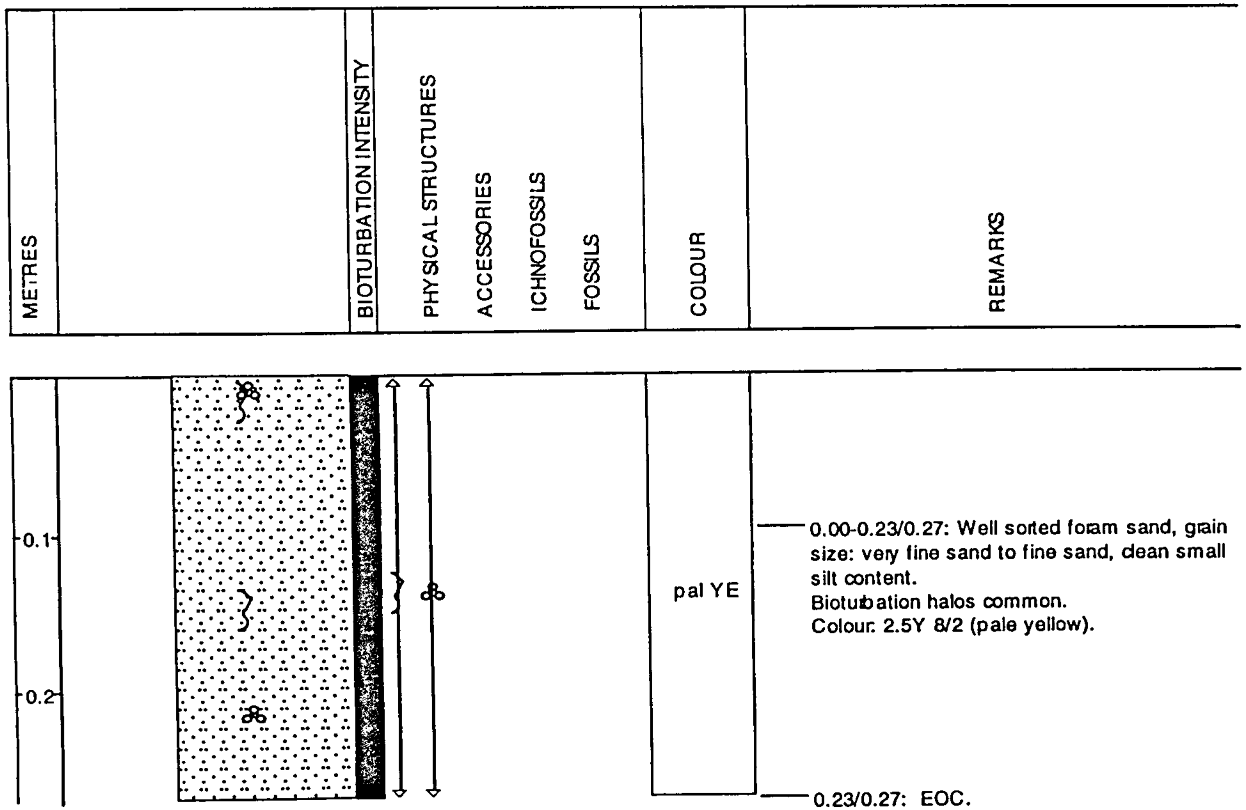
7.73-7.77: Void cause of core catcher.

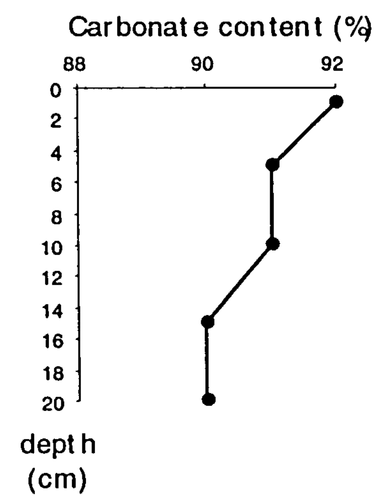

SO136-124GC
Lithology
Colour reflectance
depth (cm)
Carbonate content (%)
PWave vel. (m/s)
WBD (g/cc)
MS (SI)
depth (cm)

SO 136-138BX

Date logged: October 6, 1998
Logged by: J. R.

Site 26, South Tasman Rise
49°13.06 S, 151°05.77 E, W.D. 3022 m



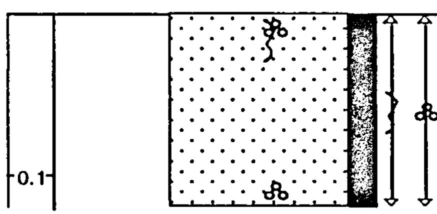


SO136-140BX

Date logged: October 6, 1998
Logged by: J.R.

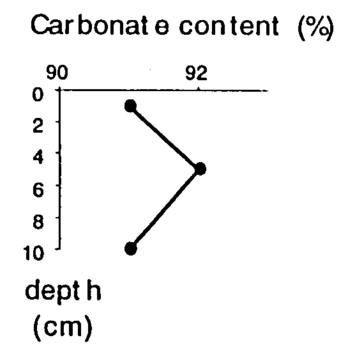
Site 27, South Tasman Rise
49°10.84 S, 150°10.13 E, W.D. 1636 m

METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ACCESSORIES	ICHNOFOSSILS	FOSSILS	REMARKS



0.00-0.12: Well sorted foram sand, grain size: very fine sand to fine sand, no clay/silt content.
Surface is disturbed cause of wave action and heaving box-core.
Bioturbation spots and halos.
Colour: 2.5Y 8/2 (pale yellow).

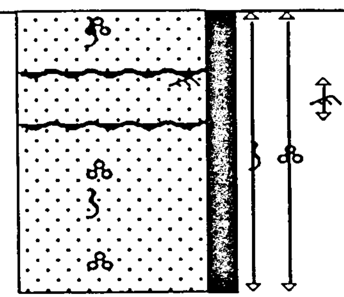
0.12: E O C.

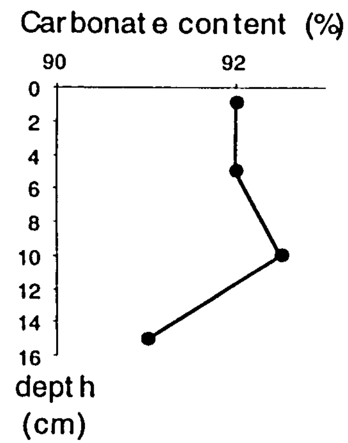


SO136-141BX

Date logged: October 6, 1998
Logged by: J.R.

Site 28, South Tasman Rise
49°08.34 S, 149°54.98 E, W.D. 1690 m

METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ICHNOFOSSILS	FOSSILS	COLOUR	REMARKS
0.1						lt GY pal YE	0.00-0.17: Medium foram sand. Streaks/flames of fine foram sand present in upper (0.00-0.04cm) and middle layer (0.04-0.07cm). Colours: 0.00-0.04: 2.5Y 7/2 (light gray). 0.04-0.07: Transition from colour above to 2.5Y 8/2 (pale yellow). 0.07-0.17: 2.5Y 8/2 (pale yellow). 0.04-0.07: Current ripple surface, which partly is covered b yforam sand. 0.17: EOC.

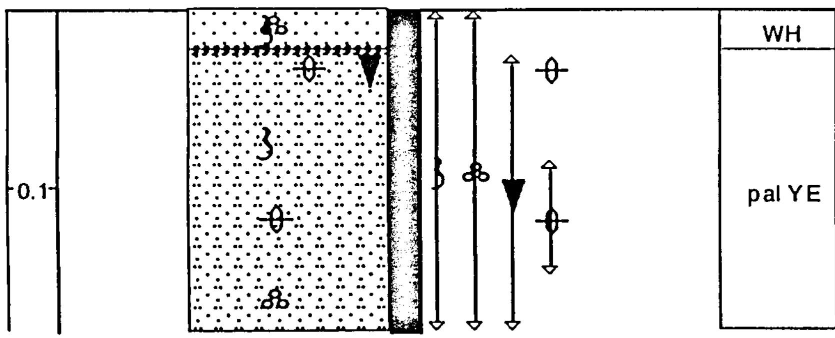


SO136-147BX

Date logged: November 7, 1998
Logged by: J.R. / S.R.

Site 29, South Tasman Rise
48°29.99 S, 149°06.75 E, W.D. 2177 m

METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ACCESSORIES	ICHNOFOSSILS	FOSSILS	COLOUR	REMARKS

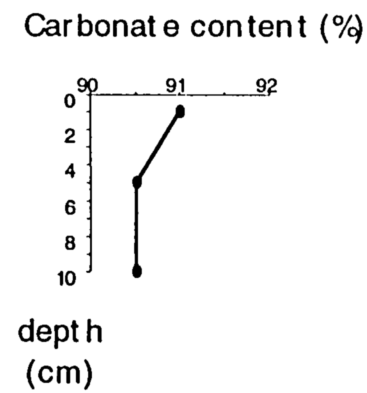


0.00-0.02: Fine to very fine foram sand with silt fraction, colour: 2.5Y 8/1 (white).

0.02-0.18: Well sorted (coarsening up) fine silty foram sand, colour 2.5Y 8/2 (pale yellow). Very fine sandy, angular black grains throughout entire box-core.

0.08-0.15: Large burrow, colour: 2.5Y 7/1 (light gray).

0.18: EOC.

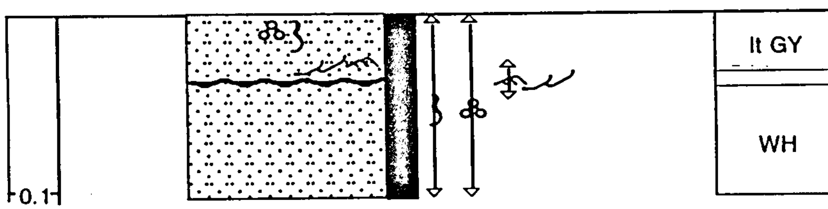


SO136-153BX

Date logged: November 8, 1995
Logged by: J. R. / S. R.

Site 31, South Tasman Rise
47°46.85 S, 149°23.73 E, W.D. 1874 m

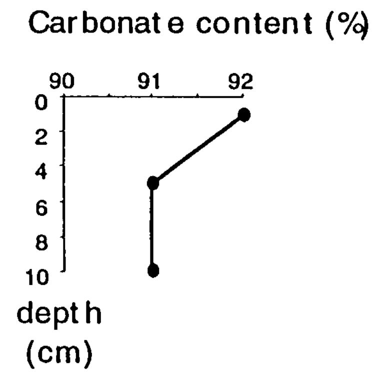
METRES		BIOTURBATION INTENSITY	PHYSICAL STRUCTURES	ACCESSORIES	ICHNOFOSSILS	FOSSILS	COLOUR	REMARKS



0.00-0.105: Fine to very fine foram sand with small % coarse silt fraction, and angular black, fine to very fine sandy grains.

0.03-0.05: Current ripple surface with flaser-like structures.
Colour changes from 2.5Y 7/2 (light gray) above, to 2.5Y 8/1 (white) below.

0.105: EOC.

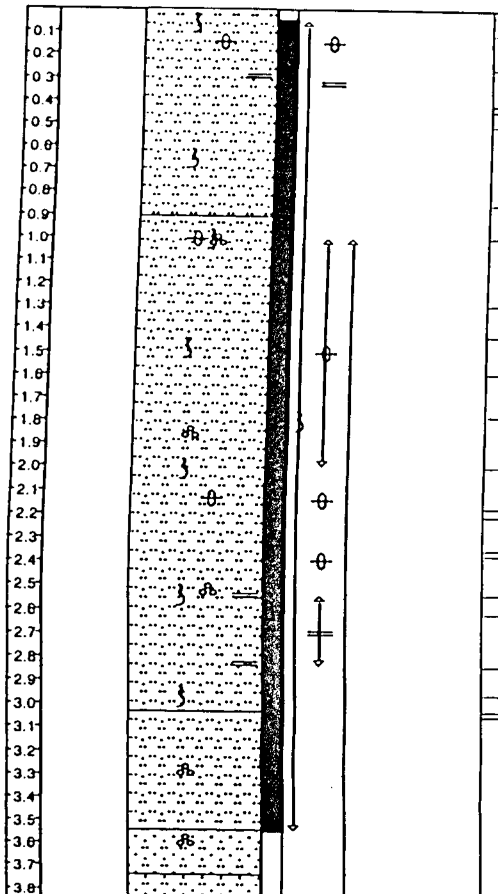


SO136-155GC

Date logged: November 9, 1998
Logged by: J. R. / G. v. d. L.

Site 32, South Tasman Rise
47°00.09 S, 149°31.30 E, wd 3208 m

METRES | BIOTURBATION INTENSITY | PHYSICAL STRUCTURES | ACCESSORIES | ICHNOFOSSILS | FOSSILS | COLOUR | REMARKS



Colour: lt GY; pal YE; pal YE / lt ye BR; vpl BR / lt GY; lt GY; WH; WH; pal RD / rd GY; WH; lt GY; pal RD; pal GN; pal GY; pal GY; pal GY / lt rd BR; pal GY; pal GY

0.00-0.91: Fine sand sized foam bearing marl ooze.
0.12-0.15: Burrow with clear halo.
0.28-0.34: Faint parallel lamination.
0.49-0.50: Colour boundary with pulled up edges.
Colours: 0.00-0.05: 2.5Y 7/2 (light gray).
0.05-0.25: 2.5Y 7/2 (light gray) grading into 2.5Y 8/2 and 2.5Y 7/3 (pale yellow).
0.25-0.42: 2.5Y 8/2 (pale yellow) with light yellowish brown streaks (2.5Y 6/4).
0.42-0.55: Combination of 2.5Y 8/2 (pale yellow) and 2.5Y 7/2 (light gray).
0.55-0.82: Mixture of 10YR 8/2 (very pale brown) and 2.5Y 7/2 (light gray).
0.82-0.91: 2.5Y 8/2 (light gray) grading into 2.5Y 7/2 (light gray).

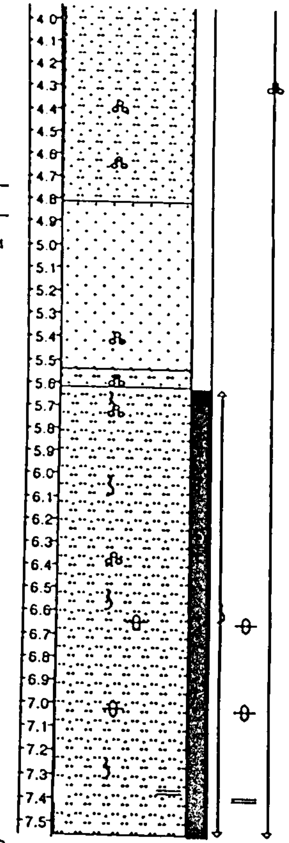
0.91-1.00: Medium sized foam bearing marl ooze, colour: 2.5Y 7/1 (light gray).

1.00-2.54: Varying fine sand to medium sand sized foam marl ooze.
Colours: 1.00-1.47: 5Y 8/1 (white) with light gray (5G 7/2) burrows and pale green laminations (5G 7/2).
1.47-1.645: 2.5Y 8/1 (white) with pale red (2.5YR 7/2) and reddish gray (2.5YR 6/1) streaks/ diagenetic horizons (pyrite, glauconite, manganese?).
1.645-1.65: Light reddish gray unit (2.5YR 7/1).
1.65-2.00: 5Y 8/1 (white) grading into 5Y 7/1 (light gray).

2.00-2.54: Mixture of 2.5YR 7/2 (pale red), 5G 7/2 (pale green) and 5Y 7/2 (pale gray). No distinct boundaries or horizons left, due to bioturbation, well mottled.

2.54-3.04: Foam marl ooze to foam (mud) sand, colours:
5Y 7/1 (pale gray) to 5Y 7/2 (light gray) with pale green (5G 7/2), pale red (2.5YR 7/2) and pale yellow (5Y 8/2) streaks.

3.04-3.42: Fining up cycle with very fine sandy foam sand on top (still silt present), to fine sand sized foam sand on bottom (phreatic horizon).
Colour 2.5Y 8/1 (white)



Colour: WH; lt GY; pal RD / lt rd BR; GY / WH; lt GY; lt gn GY; rd GY; lt GY

sand, colour 2.5Y 8/1 (white)

3.54-3.74: Medium sand sized foam sand, with some silt and mud. Some black angular grains present, colour 5Y 8/1 (white) with faint purple and light gray (10R 7/1) lamination.

3.74: Faint grain size boundary, "water level" (phreatic horizon).

3.74-5.62: Fining upwards cycle, from very fine sand, over fine sand (4.54) to medium sand. No clear boundaries detectable.
Foams, needles and spines are present, as well as black angular grains.
Colours: Gradual transition from 5Y 8/1 (white) to 5Y 7/1 (light gray).

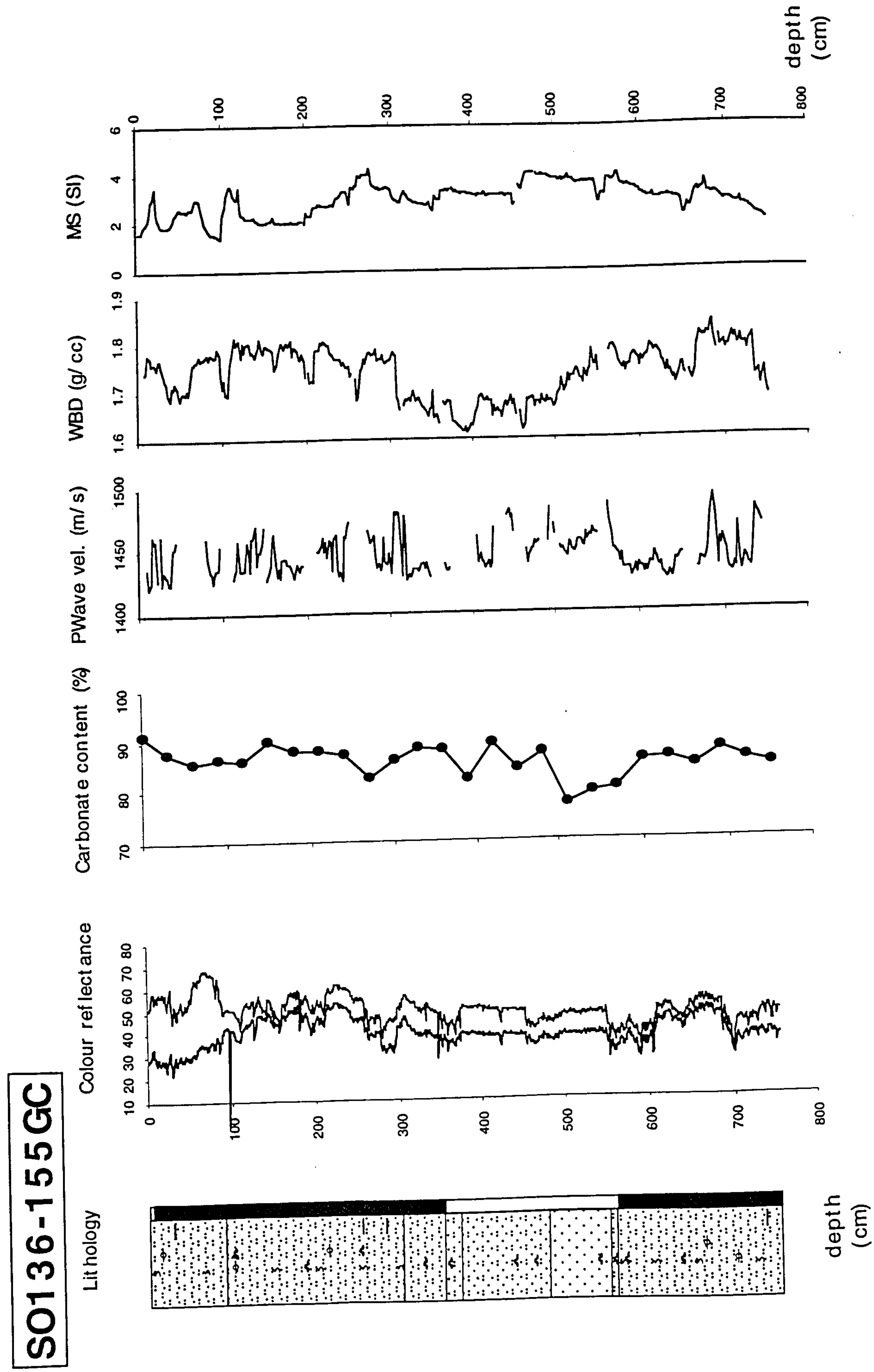
5.62: Erosive boundary.

5.62-6.81: Fining down cycle, from medium sand to foam marl ooze.
Colours: 5.62-6.04: Combination of 2.5Y 7/1 (light gray), 2.5YR 7/2 (pale red) and 2.5YR 6/4 (light reddish brown).
6.04-6.05: Purple level.
6.05-6.81: Mixture of gray (5Y 6/1), white (5Y 8/2) and light gray (5Y 7/1) colours.

6.81-7.56: Foam marl ooze. Moderate bioturbation with pale olive (5Y 6/3) burrow infills.
Colours: 6.81-6.93: Light greenish gray interval.
6.93-7.02: Reddish gray interval.
7.02-7.56: Light gray colours (5Y 7/1 & 5Y 7/2) with purple (7.40-7.42) and greenish (7.46-7.49) streaks.

7.35: Phreatic horizon.

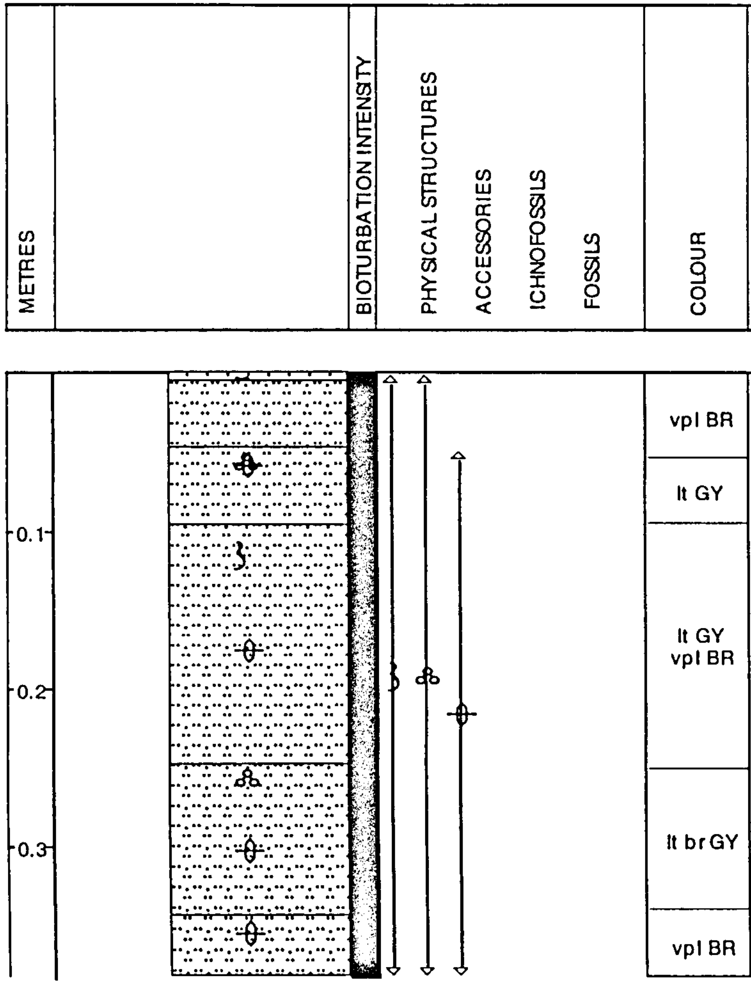
7.56: EOC.


SO136-155GC
depth (cm)
MS (SI)
WBD (g/ cc)
PWave vel. (m/ s)
Carbonate content (%)
Colour reflectance
Lithology
0 100 200 300 400 500 600 700 800

SO136-161BX

Date logged: November 9, 1998
Logged by: S. R.

Site 33, South Tasman Rise
46°33.18 S, 149°04.96 E, W.D. 3685 m



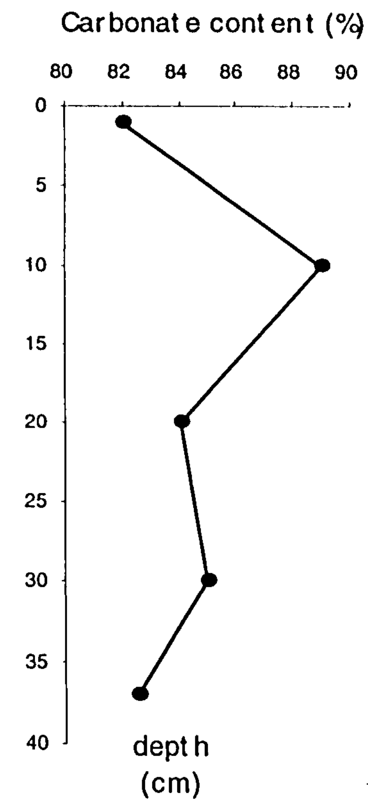
REMARKS

0.00-0.005: Fine to very fine foram sand, colour. 10YR 8/2 (very pale brown).
0.005-0.34: Coarse silty foram ooze with some angular black grains.
Colours: 0.005-0.055: 10 YR 8/3 (very pale brown).
0.055-0.095: 10YR 7/2 (light gray).
0.095-0.255: Mixture of all core colours due to heavy bioturbation.
0.255-0.34: 10YR 6/2 (light brownish gray).

0.34: Heavily bioturbated colour boundary.
0.34-0.38: Fine foram sand, colour. l=YR 8/2 (very pale brown).

Burrows (up to 3 cm i.d.) and angular black grains throughout entire core.

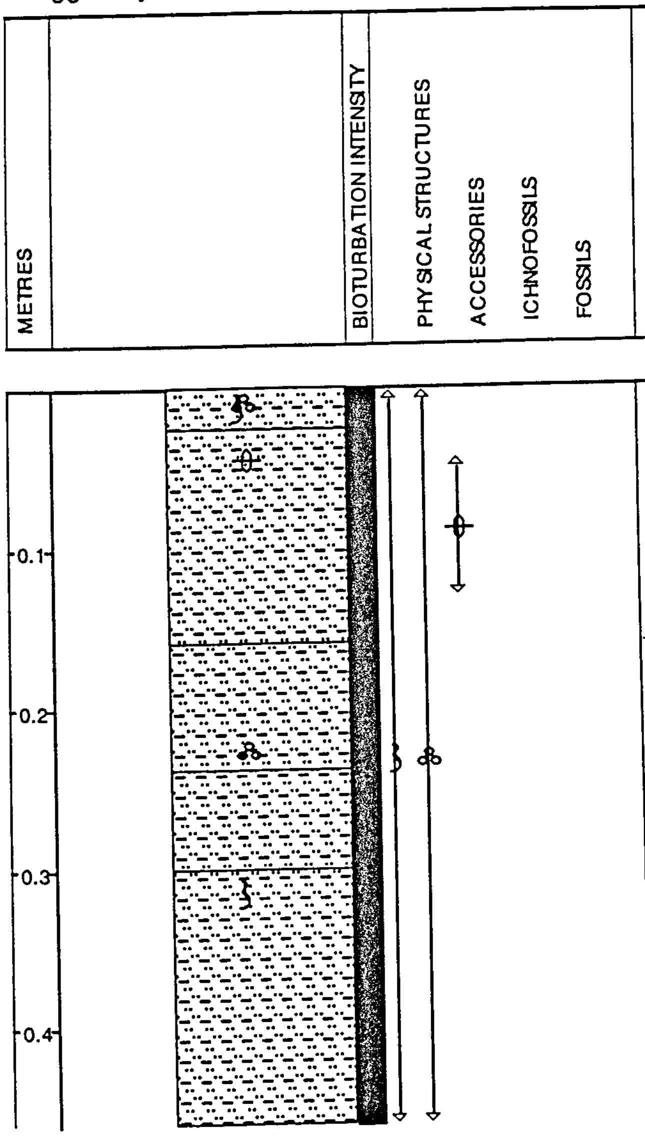
0.38: EOC.



SO136-165BX

Date logged: November 10, 1998
Logged by: J. R.

Site 35, South Tasman Rise
45°18.26 S, 147°55.13 E, W.D. 4067 m

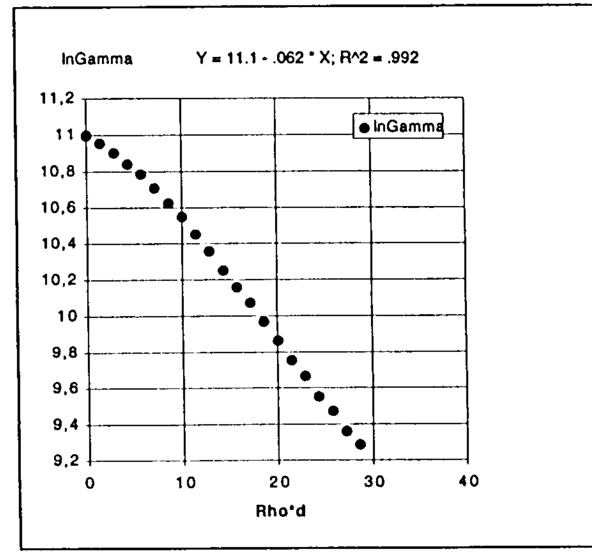


COLOUR	REMARKS
pal YE	0.00-0.03: Present-day layer (fluff).
	0.03-0.46: Foram ooze with varying % of forams. Fining upwards cycle. All boundaries are bioturbated.
	0.00-0.16: Colour: 2.5Y 8/2 (pale yellow).
lt ye BR	0.16-0.24: Light yellowish brown (2.5Y 6/3) interval with large burrows. burrow infill is material from above and below (5G 8/1, light greenish gray).
gy BR	0.24-0.30: Grayish brown (2.5Y 5/2) layer with parallel bedded burrows, some with clear halos. Dark brown layer intercalated (diagenesis horizon).
WH	0.30-0.46: Colour: 2.5Y 8/1 (white).
	Coarse grained slightly green interval at the base.
	0.46: EOC.

18. Oct. 1998; gamma calibration

Number of plates*	thickness (mm)	rho*d	rho*d^2	Gamma(2 sec)	lnGamma
21	111,30	30,05	903,06		
20	106,00	28,62	819,10	10791	9,29
19	100,70	27,19	739,24	11624	9,36
18	95,40	25,76	663,47	12976	9,47
17	90,10	24,33	591,80	14039	9,55
16	84,80	22,90	524,23	15769	9,67
15	79,50	21,47	460,75	17212	9,75
14	74,20	20,03	401,36	19243	9,86
13	68,90	18,60	346,07	21361	9,97
12	63,60	17,17	294,88	23671	10,07
11	58,30	15,74	247,78	25835	10,16
10	53,00	14,31	204,78	28361	10,25
9	47,70	12,88	165,87	31522	10,36
8	42,40	11,45	131,06	34595	10,45
7	37,10	10,02	100,34	38235	10,55
6	31,80	8,59	73,72	41229	10,63
5	26,50	7,16	51,19	44709	10,71
4	21,20	5,72	32,76	48303	10,79
3	15,90	4,29	18,43	51178	10,84
2	10,60	2,86	8,19	54471	10,91
1	5,30	1,43	2,05	57271	10,96
0	0,00	0,00	0,00	59906	11,00
0	0,00	0,00	0,00	59748	11,00

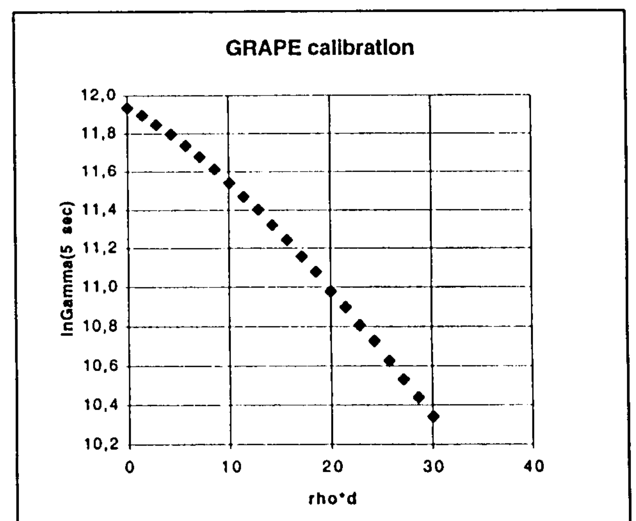
*Plates are 5.3 mm
Aluminum has density of 2.7 g/cc



Linear Y = 11.1 - .062 * X; R^2 = .992
Polynomial Y = 11.029 - .044 * X-6.47E-4*X^2; R^2 = .998

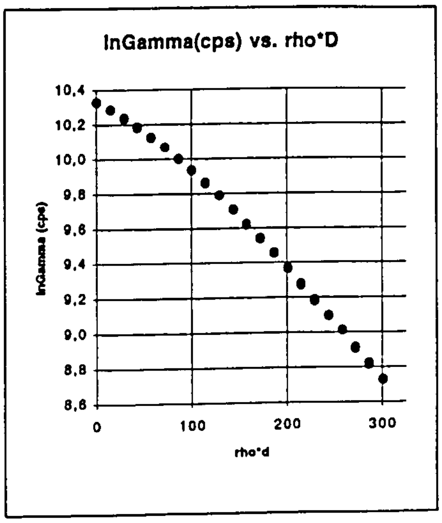
24 Oct. 1998; gamma calibration

Number plates	thickness(mm)	rho*d	rho*d^2	Gamma(5 sec)	lnGamma
21	111,30	30,05	903,06	30945,00	10,34
20	106,00	28,62	819,10	34145,00	10,44
19	100,70	27,19	739,24	37425,00	10,53
18	95,40	25,76	663,47	41205,00	10,63
17	90,10	24,33	591,80	45538,00	10,73
16	84,80	22,90	524,23	49394,00	10,81
15	79,50	21,47	460,75	54014,00	10,90
14	74,20	20,03	401,36	58492,00	10,98
13	68,90	18,60	346,07	64746,00	11,08
12	63,60	17,17	294,88	70026,00	11,16
11	58,30	15,74	247,78	76348,00	11,24
10	53,00	14,31	204,78	82683,00	11,32
9	47,70	12,88	165,87	89607,00	11,40
8	42,40	11,45	131,06	95826,00	11,47
7	37,10	10,02	100,34	102900,00	11,54
6	31,80	8,59	73,72	110396,00	11,61
5	26,50	7,16	51,19	117997,00	11,68
4	21,20	5,72	32,76	125278,00	11,74
3	15,90	4,29	18,43	132704,00	11,80
2	10,60	2,86	8,19	139450,00	11,85
1	5,30	1,43	2,05	146533,00	11,90
0	0,00	0,00	0,00	152674,00	11,94

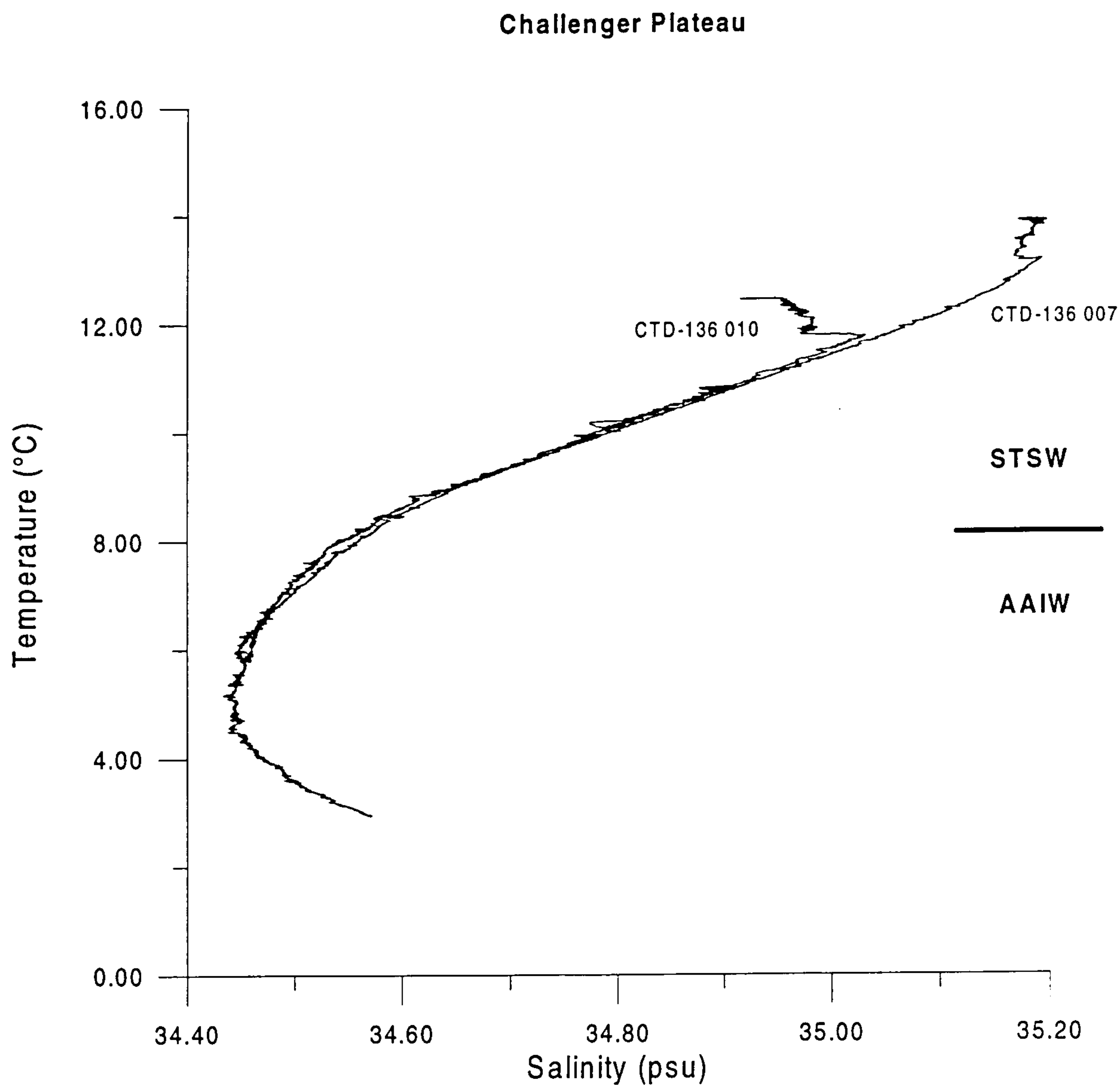


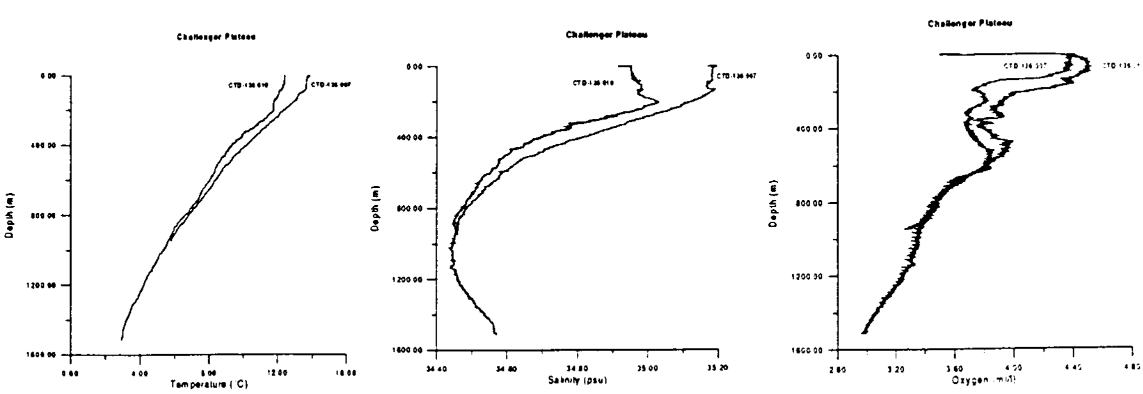
regression: Y = 10.343 -0.035*X -0.0006274*X^2
R^2 = 1

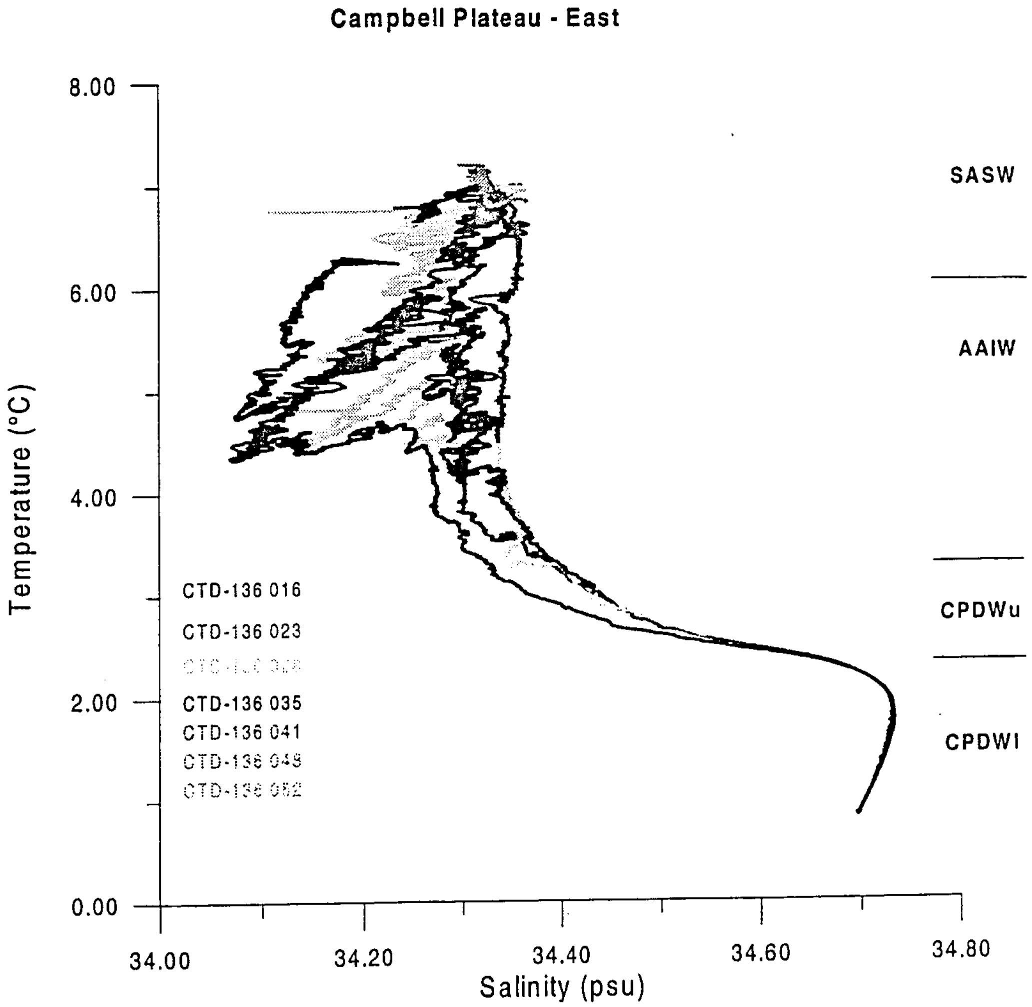
27. Oct. 1998; gamma calibration					5 second integrations		
plates	d	rho*d	rho*d^2	Gamma(count)	lnGamma(count)	Gamma(cps)	lnGamma(cps)
21	111,30	300,51	90306,26	30934,00	10,34	6186,80	8,73
21	111,30	300,51	90306,26	30858,00	10,34	6171,60	8,73
20	106,00	286,20	81910,44	34060,00	10,44	6812,00	8,83
20	106,00	286,20	81910,44	33859,00	10,43	6771,80	8,82
20	106,00	286,20	81910,44	33920,00	10,43	6784,00	8,82
20	106,00	286,20	81910,44	33709,00	10,43	6741,80	8,82
19	100,70	271,89	73924,17	37243,00	10,53	7448,60	8,92
19	100,70	271,89	73924,17	37043,00	10,52	7408,60	8,91
19	100,70	271,89	73924,17	36871,00	10,52	7374,20	8,91
19	100,70	271,89	73924,17	37105,00	10,52	7421,00	8,91
18	95,40	257,58	66347,46	40977,00	10,62	8195,40	9,01
18	95,40	257,58	66347,46	41170,00	10,63	8234,00	9,02
17	90,10	243,27	59180,29	44699,00	10,71	8939,80	9,10
17	90,10	243,27	59180,29	44568,00	10,70	8913,60	9,10
16	84,80	228,96	52422,68	48541,00	10,79	9708,20	9,18
16	84,80	228,96	52422,68	49049,00	10,80	9809,80	9,19
16	84,80	228,96	52422,68	49002,00	10,80	9800,40	9,19
15	79,50	214,65	46074,62	53544,00	10,89	10708,80	9,28
15	79,50	214,65	46074,62	53591,00	10,89	10718,20	9,28
15	79,50	214,65	46074,62	53390,00	10,89	10678,00	9,28
15	79,50	214,65	46074,62	53045,00	10,88	10609,00	9,27
14	74,20	200,34	40136,12	58550,00	10,98	11710,00	9,37
14	74,20	200,34	40136,12	58694,00	10,98	11738,80	9,37
14	74,20	200,34	40136,12	58326,00	10,97	11665,20	9,36
13	68,90	186,03	34607,16	63630,00	11,06	12726,00	9,45
13	68,90	186,03	34607,16	63924,00	11,07	12784,80	9,46
13	68,90	186,03	34607,16	64048,00	11,07	12809,60	9,46
13	68,90	186,03	34607,16	64129,00	11,07	12825,80	9,46
12	63,60	171,72	29487,76	69394,00	11,15	13878,80	9,54
12	63,60	171,72	29487,76	69824,00	11,15	13964,80	9,54
12	63,60	171,72	29487,76	69567,00	11,15	13913,40	9,54
12	63,60	171,72	29487,76	69756,00	11,15	13951,20	9,54
11	58,30	157,41	24777,91	75652,00	11,23	15130,40	9,62
11	58,30	157,41	24777,91	75616,00	11,23	15123,20	9,62
11	58,30	157,41	24777,91	75130,00	11,23	15026,00	9,62
11	58,30	157,41	24777,91	75603,00	11,23	15120,60	9,62
10	53,00	143,10	20477,61	82062,00	11,32	16412,40	9,71
10	53,00	143,10	20477,61	82276,00	11,32	16455,20	9,71
10	53,00	143,10	20477,61	82238,00	11,32	16447,60	9,71
10	53,00	143,10	20477,61	82173,00	11,32	16434,60	9,71
9	47,70	128,79	16586,86	89212,00	11,40	17842,40	9,79
9	47,70	128,79	16586,86	88934,00	11,40	17786,80	9,79
9	47,70	128,79	16586,86	89007,00	11,40	17801,40	9,79
9	47,70	128,79	16586,86	88994,00	11,40	17798,80	9,79
8	42,40	114,48	13105,67	95983,00	11,47	19196,60	9,86
8	42,40	114,48	13105,67	95577,00	11,47	19115,40	9,86
8	42,40	114,48	13105,67	96321,00	11,48	19264,20	9,87
8	42,40	114,48	13105,67	95801,00	11,47	19160,20	9,86
7	37,10	100,17	10034,03	103213,00	11,54	20642,60	9,94
7	37,10	100,17	10034,03	103354,00	11,55	20670,80	9,94
7	37,10	100,17	10034,03	103221,00	11,54	20644,20	9,94
7	37,10	100,17	10034,03	103097,00	11,54	20619,40	9,93
6	31,80	85,86	7371,94	110501,00	11,61	22100,20	10,00
6	31,80	85,86	7371,94	110228,00	11,61	22045,60	10,00
6	31,80	85,86	7371,94	110190,00	11,61	22038,00	10,00
6	31,80	85,86	7371,94	110103,00	11,61	22020,60	10,00
5	26,50	71,55	5119,40	118073,00	11,68	23614,60	10,07
5	26,50	71,55	5119,40	118024,00	11,68	23604,80	10,07
5	26,50	71,55	5119,40	117881,00	11,68	23576,20	10,07
5	26,50	71,55	5119,40	117853,00	11,68	23570,60	10,07
4	21,20	57,24	3276,42	124655,00	11,73	24931,00	10,12
4	21,20	57,24	3276,42	125212,00	11,74	25042,40	10,13
4	21,20	57,24	3276,42	124716,00	11,73	24943,20	10,12
4	21,20	57,24	3276,42	124710,00	11,73	24942,00	10,12
3	15,90	42,93	1842,98	132442,00	11,79	26488,40	10,18
3	15,90	42,93	1842,98	132684,00	11,80	26536,80	10,19
3	15,90	42,93	1842,98	132096,00	11,79	26419,20	10,18
3	15,90	42,93	1842,98	133064,00	11,80	26612,80	10,19
2	10,60	28,62	819,10	139237,00	11,84	27847,40	10,23
2	10,60	28,62	819,10	139734,00	11,85	27946,80	10,24
2	10,60	28,62	819,10	139374,00	11,84	27874,80	10,24
2	10,60	28,62	819,10	139125,00	11,84	27825,00	10,23
1	5,30	14,31	204,78	146155,00	11,89	29231,00	10,28
1	5,30	14,31	204,78	146107,00	11,89	29221,40	10,28
1	5,30	14,31	204,78	146413,00	11,89	29282,60	10,28
1	5,30	14,31	204,78	146662,00	11,90	29332,40	10,29
0	0,00	0,00	0,00	152734,00	11,94	30546,80	10,33
0	0,00	0,00	0,00	153237,00	11,94	30647,40	10,33
0	0,00	0,00	0,00	153211,00	11,94	30642,20	10,33
0	0,00	0,00	0,00	153011,00	11,94	30602,20	10,33

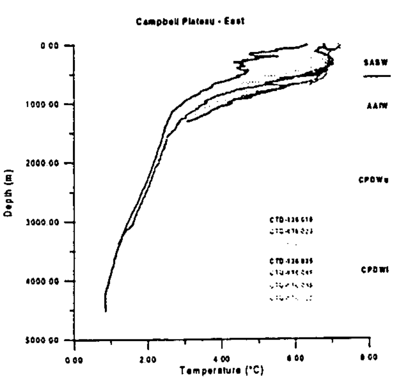


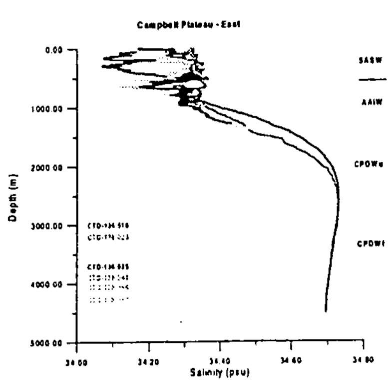
regression: Y=10.344-0.03566*X-0.0006257*X^2
r^2 = 1

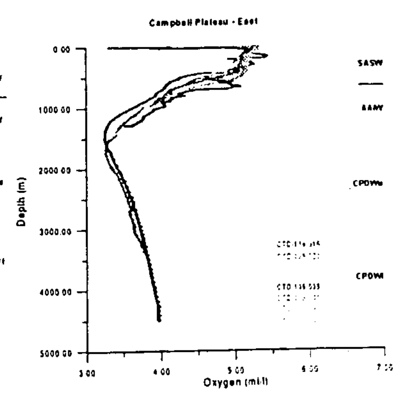

Challenger Plateau
16.00
12.00
8.00
4.00
0.00
Temperature (°C)
CTD-136 010
CTD-136 007
STSW
AAIW
34.40
34.60
34.80
35.00
35.20
Salinity (psu)

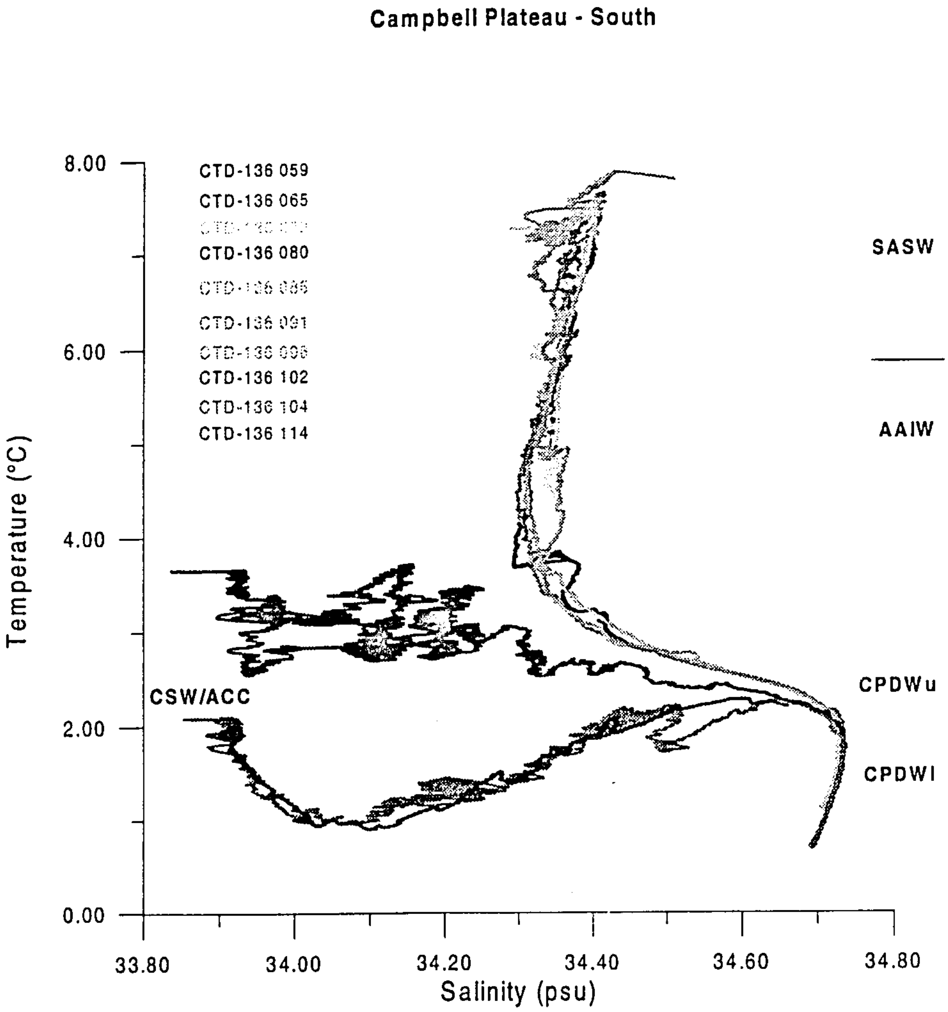

Challenger Plateau
Challenger Plateau
Challenger Plateau
Depth (m)
Salinity (psu)

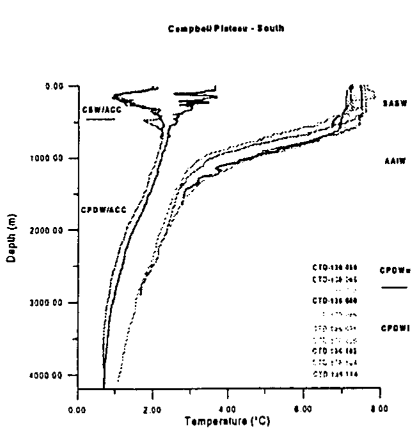

Campbell Plateau - East
8.00
6.00
4.00
2.00
0.00
Temperature (°C)
34.00
34.20
34.40
34.60
34.80
Salinity (psu)
SASW
AAIW
CPDWu
CPDWl
CTD-136 016
CTD-136 023
CTD-136 035
CTD-136 041
CTD-136 049
CTD-136 052

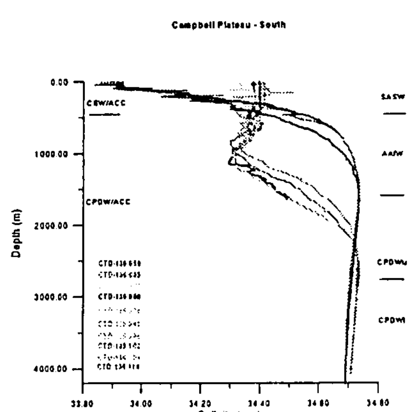

Campbell Plateau - East
Depth (m)
Temperature (°C)
SASW
AAIW
CPDWu
CPDWl

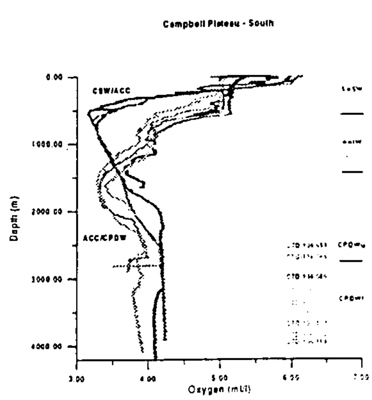

Campbell Plateau - East
Depth (m)
Salinity (psu)
SASW
AAIW
CPDWu
CPDWl

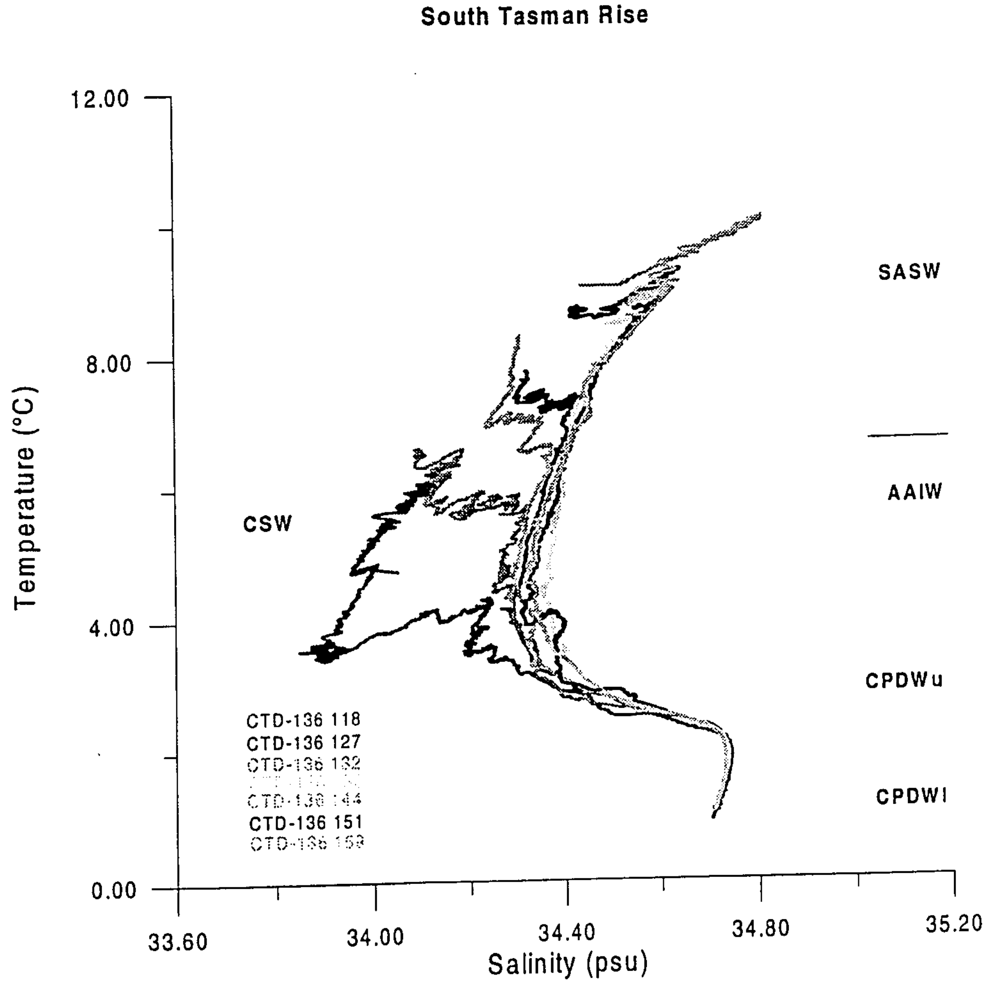

Campbell Plateau - East
Depth (m)
Oxygen (ml/l)
SASW
AAIW
CPDWu
CPDWl

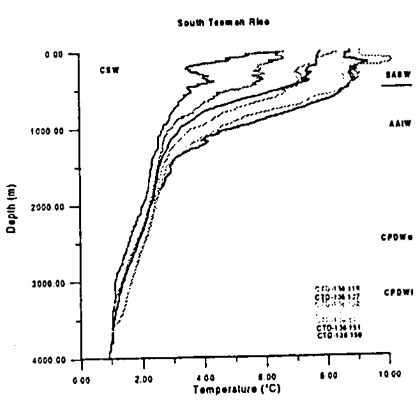

Campbell Plateau - South
CTD-136 059
CTD-136 065
CTD-136 080
CTD-136 102
CTD-136 104
CTD-136 114
SASW
AAIW
CPDWu
CPDWl
CSW/ACC
Temperature (°C)
Salinity (psu)
8.00
6.00
4.00
2.00
0.00
33.80
34.00
34.20
34.40
34.60
34.80

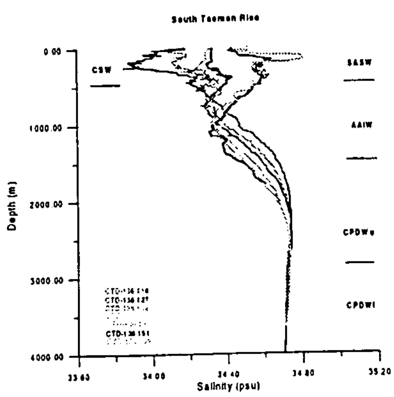

Campbell Plateau - South
SASW
AAIW
CPDWu
CPDWl
CSW/ACC
CPDW/ACC
Depth (m)
Temperature (°C)

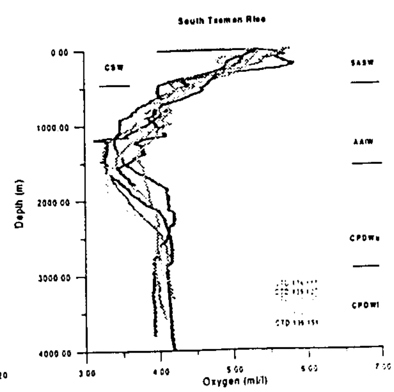

Campbell Plateau - South
SASW
AAIW
CPDWu
CPDWl
CSW/ACC
CPDW/ACC
Depth (m)
Salinity (psu)


Campbell Plateau - South
CSW/ACC
ACC/CPDW
Depth (m)
Oxygen (ml/l)


South Tasman Rise
12.00
8.00
4.00
0.00
Temperature (°C)
CSW
SASW
AAIW
CPDWu
CPDWl
CTD-136 118
CTD-136 127
CTD-136 132
CTD-136 144
CTD-136 151
33.60
34.00
34.40
34.80
35.20
Salinity (psu)

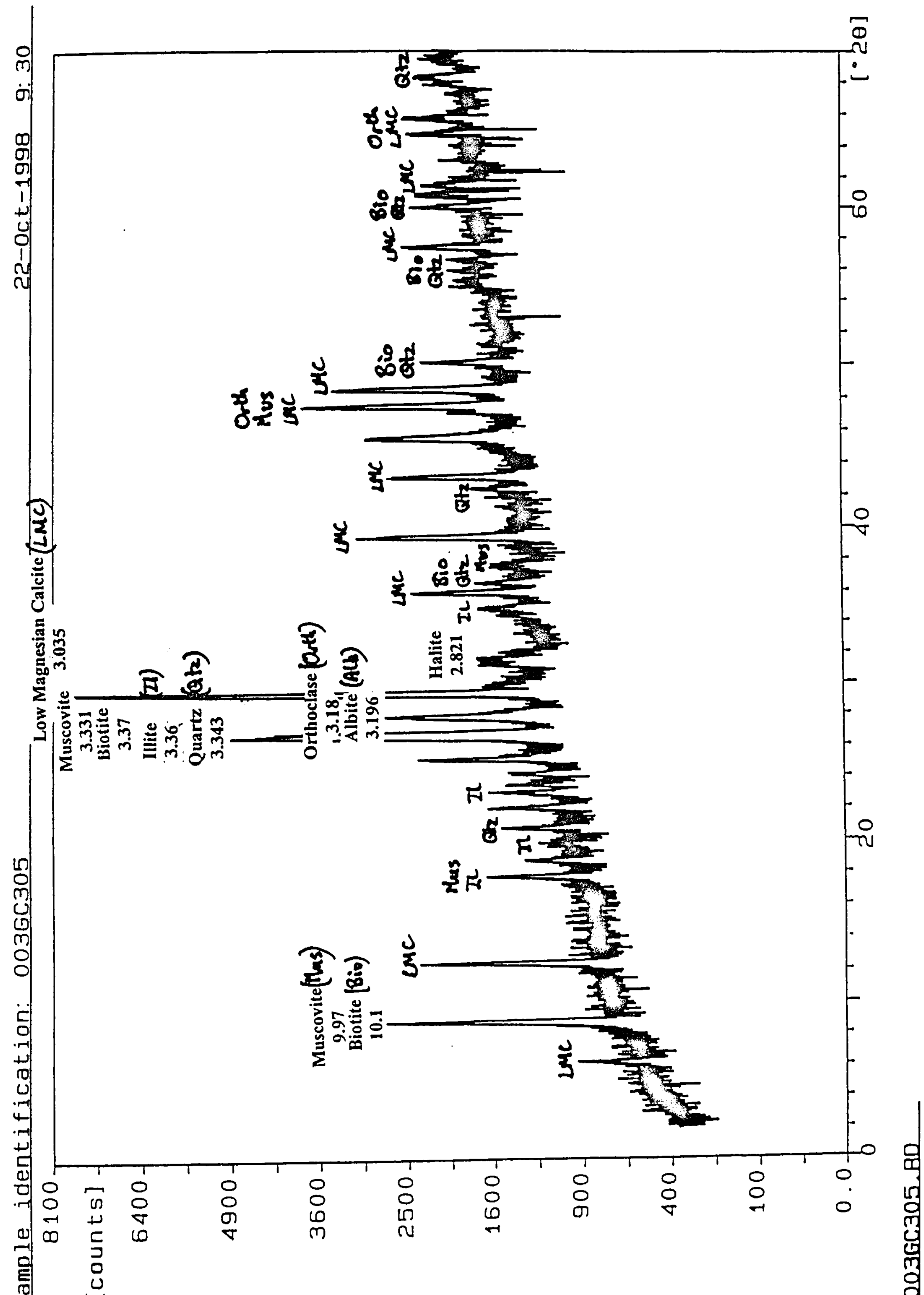

South Tasman Rise
CSW
SASW
AAIW
CPDWu
CPDWl
Depth (m)
Temperature (°C)


South Tasman Rise
CSW
SASW
AAIW
CPDWu
CPDWl
Depth (m)
Salinity (psu)

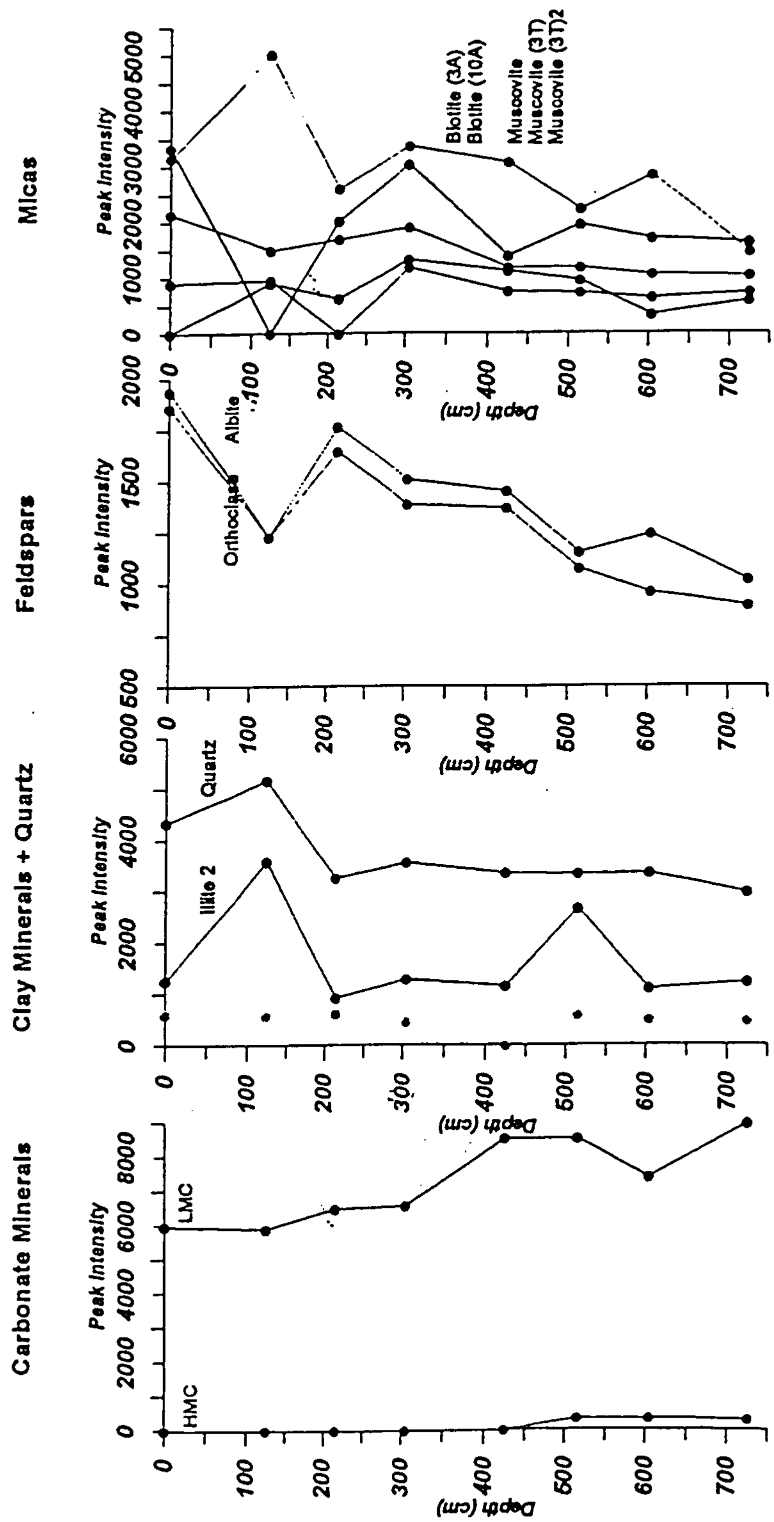

South Tasman Rise
CSW
SASW
AAIW
CPDWu
CPDWl
Depth (m)
Oxygen (ml/l)

Minerals	Carbonate Minerals				Quartz	Clay Minerals				Micas					Feldspars		Halite
	Aragonite	Low Mg Calcite	High Mg Calcite	Dolomite		Illite 1	Illite 2	Illite 3	Smectite/ Kaolinite	Biotite (3A)	Biotite (10A)	Muscovite	Muscovite (3T)	Muscovite (3T)2	Orthoclase	Albite	
d(A)	3,396	3,035	2,996	2,886	3,343	4,46	3,36	2,57	7,24	3,37	10,1	3,32	9,97	3,331	3,18	3,196	2,821
Challenger Plateau (Sites 1 and 2)																	
003GC05	None	5980	None	Trace?	4354	Trace?	1264?	614?	None	Trace	920	3336?	2163	3172	1863?	1942?	714?
003GC125	None	5888	None	None	5183	Trace	3599?	581?	None	897?	961?	Trace?	1502?	5023?	1233*	1233*	593?
003GC215	None	6478	None	None	3276	Trace?	936?	623?	None	617?	None	2014?	1697?	2611?	1650?	1770?	575?
003GC305	None	6564	None	Trace?	3574	None	1295?	461?	None	1308?	1186?	3020?	1899?	3366?	1390?	1512?	527?
003GC425	None	8541	None	Trace?	3368	None	1167?	None	None	1108?	760?	1374?*	1185?	3076?	1374?*	1455?	506?
003GC515	None	8541	388?	Trace?	3353	None	2673?	586?	None	937?	734?	1936?	1180?	2228?	1078?	1157?	610?
003GC605	None	7410	339?	Trace?	3365	None	1109?	493?	None	321?	641?	1695?	1061?	2845?	963?	1248?	527?
003GC725	None	8966	300?	None	2990	None	1239?	481?	None	567?	729?	1617?	1034?	1460?	897?	1023?	647?
004MUC00	None	6917	None	None	4651	None	2339?	594?	None	697?	927?	2976?	1658?	3344?	1354?	1684?	647?
011GC01	None	3620	504?	None	3939	Trace?	2820?	644?	None	969?	926?	3159?	1557?	3779?	1483?	1376?	785?

KEY: None= mineral appears to be absent; Number= mineral intensity; Number+?= possible presence of the mineral shown as intensity; Trace?= mineral possibly there but appears within the noise band

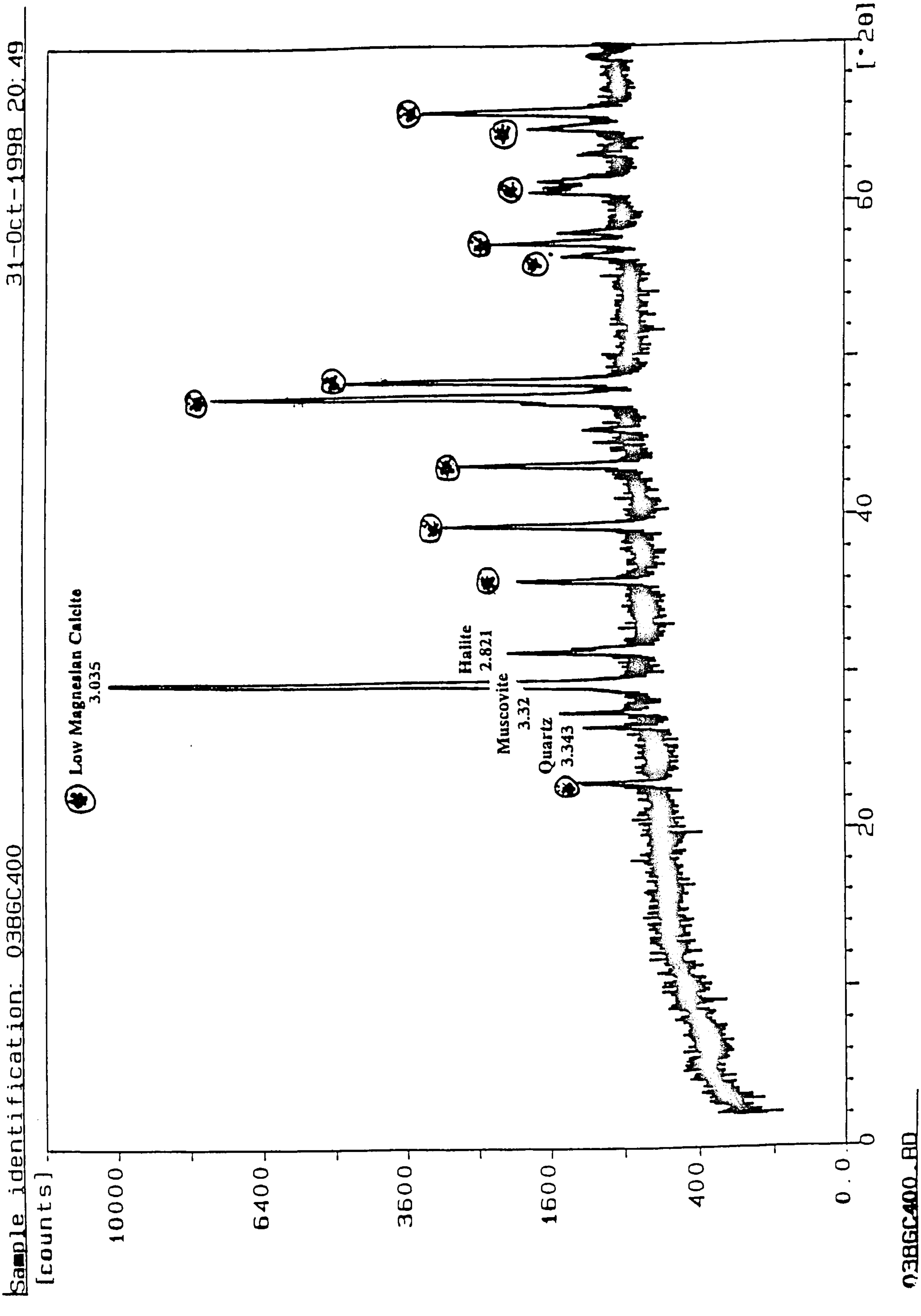

Sample identification: 003GC305
22-Oct-1998 9:30
[counts]
8100
6400
4900
3600
2500
1600
900
400
100
0.0
0
20
40
60
[°2θ]
003GC305.RD
Low Magnesian Calcite (LMC)
3.035
Muscovite
3.331
Biotite
3.37
Illite
3.36
(IL)
Quartz
3.343
(Qtz)
Orthoclase (Orth)
3.18
Albite (Alb)
3.196
Halite
2.821
Muscovite (Mus)
9.97
Biotite (Bio)
10.1

SO 136 Challenger Plateau
Changes in downcore mineralogy at Site 01, Station 003

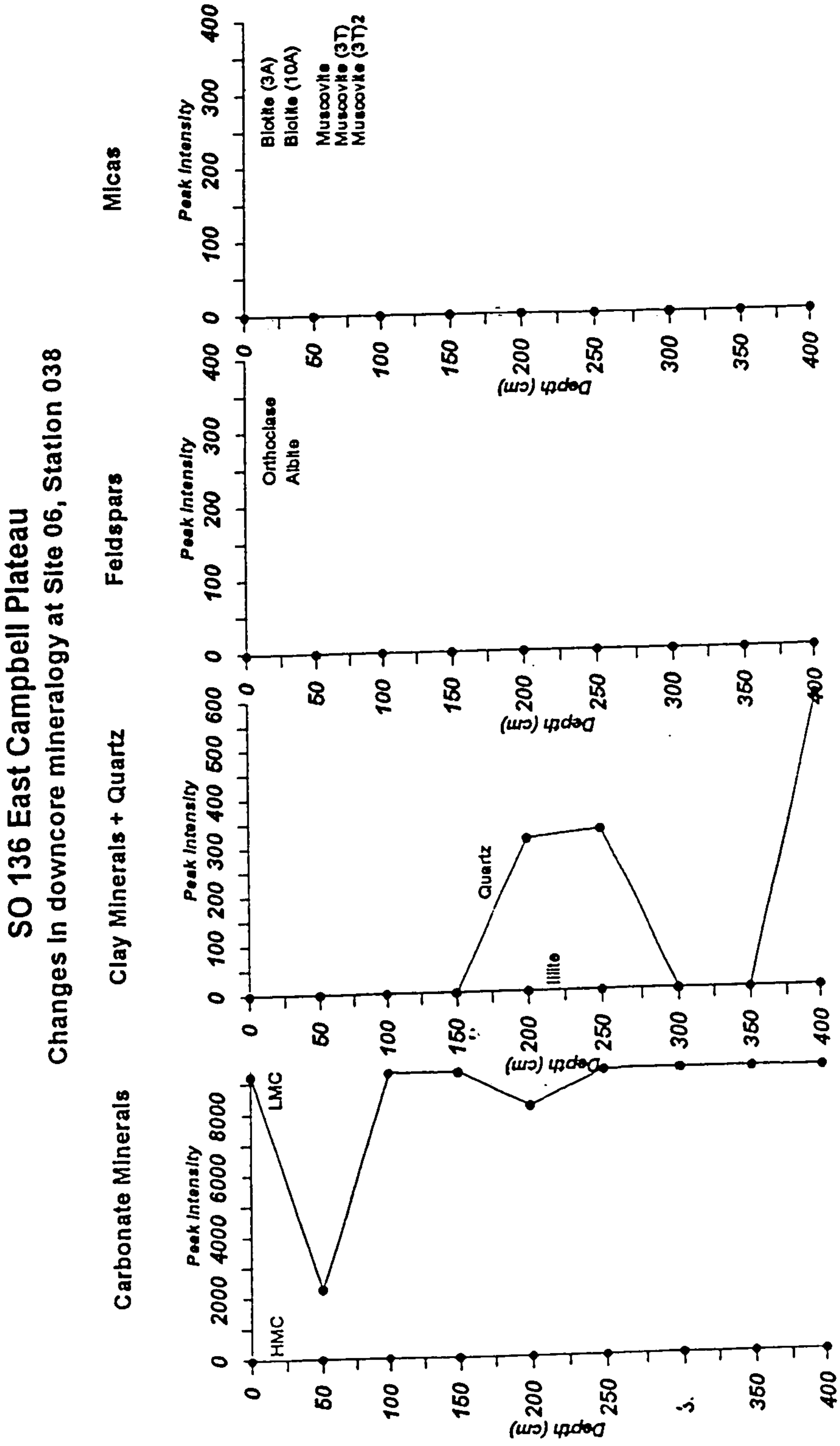


Minerals	Carbonate Minerals					Clay Minerals				Micas					Feldspars		
	Aragonite	Low Mg Calcite	High Mg Calcite	Dolomite	Quartz	Illite 1	Illite 2	Illite 3	Smectite/ Kaolinite	Biotite (3A)	Biotite (10A)	Muscovite	Muscovite (3T)	Muscovite (3T)2	Orthoclase	Albite	Halite
d(A)	3,396	3,035	2,998	2,886	3,343	4,46	3,36	2,57	7,24	3,37	10,1	3,32	9,97	3,331	3,18	3,196	2,821
E. Campbell Plateau (Sites 3 to 9)																	
025BXTL	None	9204	None	None	694	None	576?	None	None	278?	None	295?	None	554?	None	None	836?
025BXML	None	9190	None	None	694	None	576?	None	None	278?	None	295?	None	554?	None	None	836?
025BXBL	None	Trace?	Trace?	None	4713	Trace?	3746?	None	None	802?	Trace?	2684?	336?	None	594?	393?	1595?
031BXTL	None	9204	None	None	1661	None	795?	None	None	537?	None	274?	None	1744?	763?*	763?*	1354?
031BXBL	None	9310	None	None	None	None	None	None	None	None	None	None	None	None	None	None	633?
038GC000	None	9266	None	None	None	None	None	None	None	None	None	None	None	None	None	None	633?
038GC050	None	2294	None	None	None	None	None	None	None	None	None	None	None	None	None	None	1352?
038GC100	None	9313	None	None	None	None	None	None	None	None	None	None	None	None	None	None	741?
038GC150	None	9295	None	None	None	None	None	None	None	None	None	None	None	None	None	None	748?
038GC200	None	8160	None	None	314?	None	None	None	None	None	None	None	None	None	None	None	560?
038GC250	None	9290	None	None	331?	None	None	None	None	None	None	None	None	None	None	None	795?
038GC300	None	9302	None	None	None	None	None	None	None	None	None	None	None	None	None	None	602?
038GC350	None	9300	None	None	None	None	None	None	None	None	None	None	None	None	None	None	609?
038GC400	None	9281	None	None	601?	None	None	None	None	None	None	None	None	503?	None	None	600?
044GC002	None	9298	None	None	None	None	None	None	None	None	None	None	None	None	None	None	1184?
051GC001	None	9297	None	None	None	None	None	None	None	None	None	None	None	None	None	None	892?
055GC000	None	9285	None	None	468?	None	378?	None	None	272?	None	280?	None	401?	None	None	496?

KEY: None= mineral appears to be absent; Number= mineral intensity; Number+?= possible presence of the mineral shown as intensity; Trace?= mineral possibly there but appears within the noise band

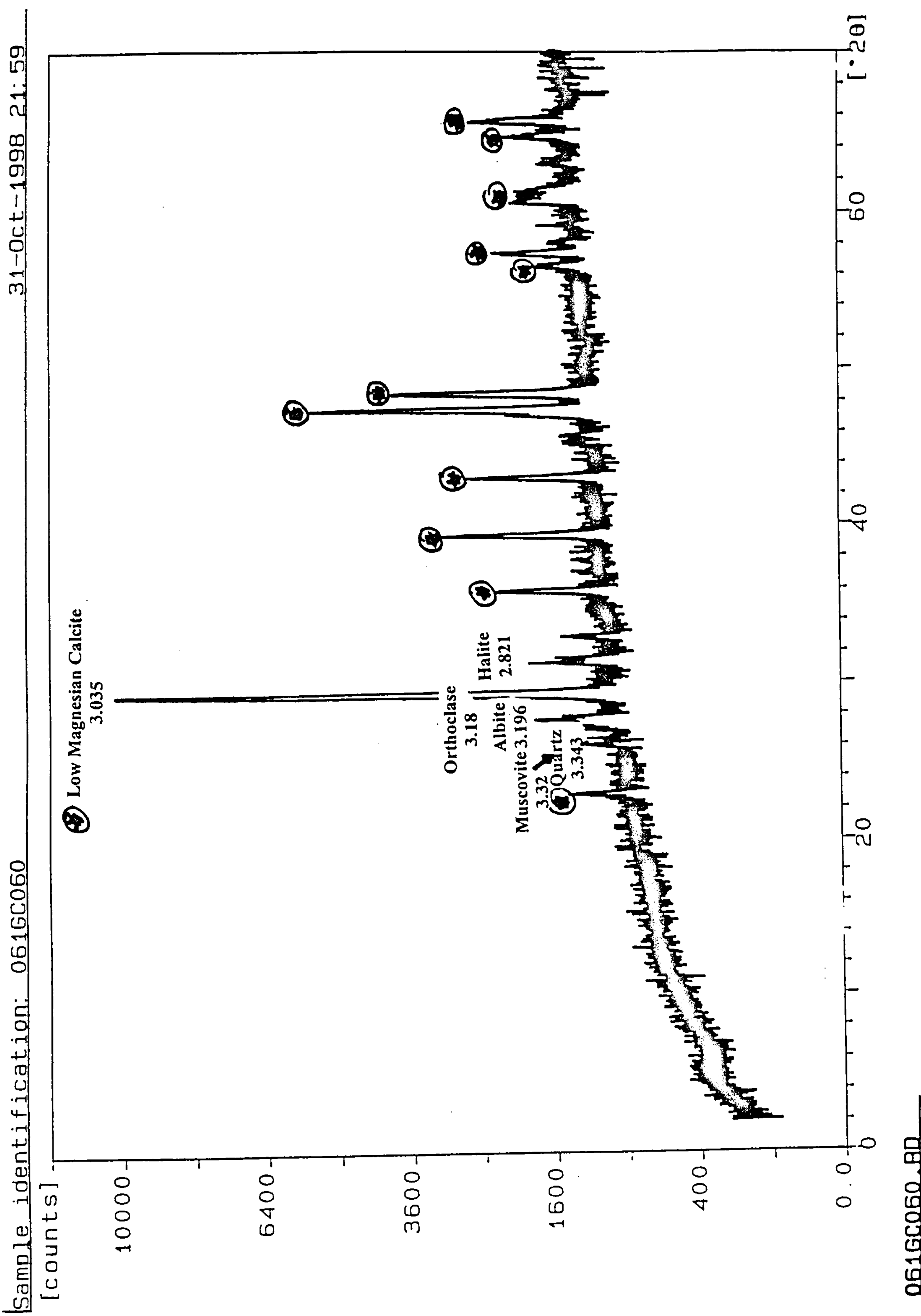


Sample identification: 03BGC400
31-Oct-1998 20:49
[counts]
10000
6400
3600
1600
400
0.0
0
20
40
60
[°2θ]
Low Magnesian Calcite
3.035
Halite
2.821
Muscovite
3.32
Quartz
3.343
03BGC400.RD

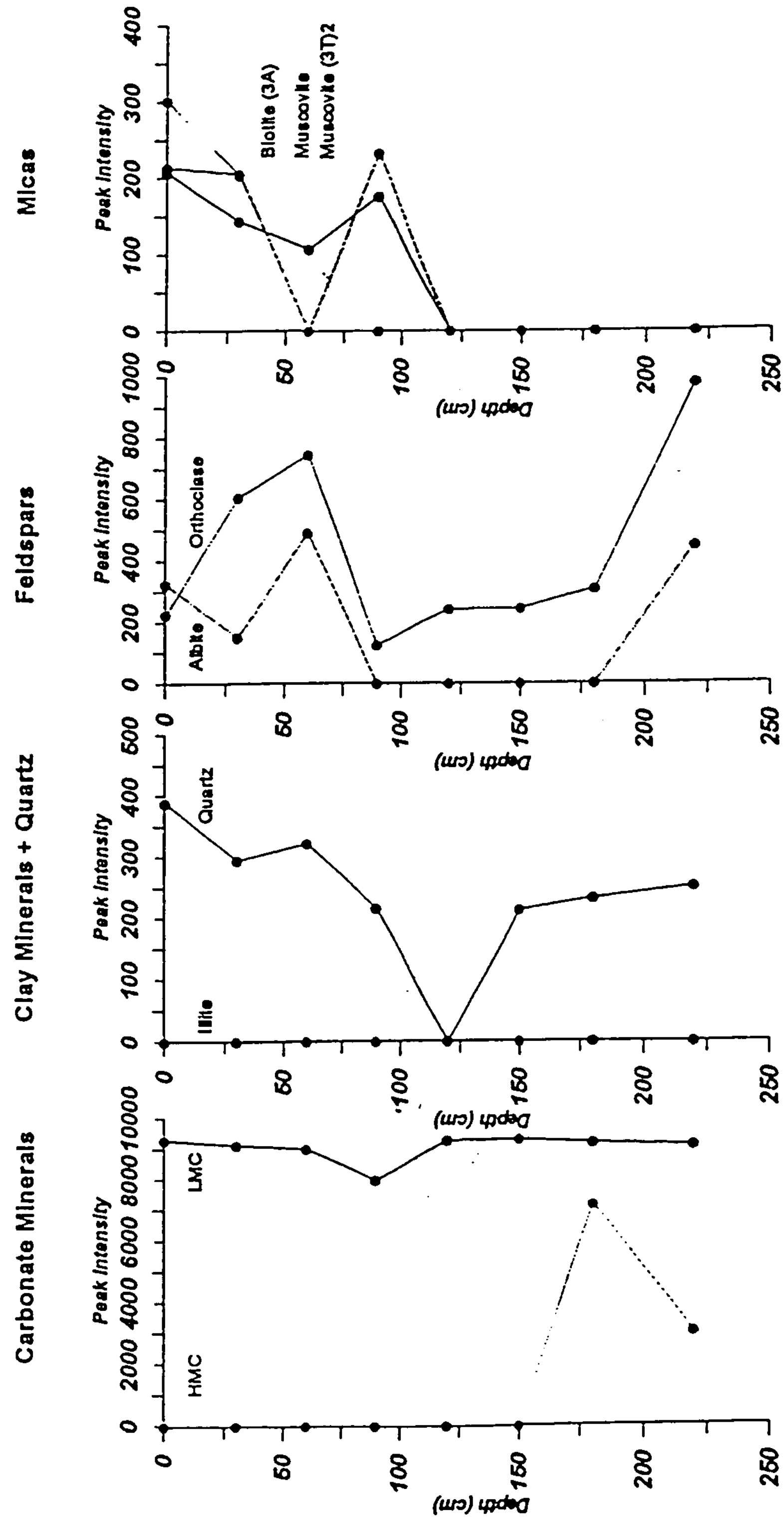

SO 136 East Campbell Plateau
Changes in downcore mineralogy at Site 06, Station 038
Carbonate Minerals
Clay Minerals + Quartz
Feldspars
Micas
Peak Intensity
Depth (cm)
LMC
HMC
Quartz
Illite
Orthoclase
Albite
Biotite (3A)
Biotite (10A)
Muscovite
Muscovite (3T)
Muscovite (3T)2

Minerals	Carbonate Minerals					Clay Minerals				Micas					Feldspars				
	Aragonite	Low Mg Calcite	High Mg Calcite	Dolomite	Quartz	Illite 1	Illite 2	Illite 3	Smectite/ Kaolinite	Biotite (3A)	Biotite (10A)	Muscovite	Muscovite (3T)	Muscovite (3T)2	Orthoclase	Albite	Halite	Hornblende	Titanite
d(A)	3,398	3,035	2,998	2,886	3,343	4,46	3,36	2,57	7,24	3,37	10,1	3,32	9,97	3,331	3,18	3,196	2,821	2,7	3,24
W. Campbell Plateau (Sites 10 to 16)																			
061GC002	None	9296	None	None	390	None	336?	None	None	214?	Trace?	207?	None	302?	325?	228?	542?	None	None
061GC030	270?	9131	None	None	296	None	243?	None	None	205?	None	143?	None	204?	152?	610?	552?	383?	257?
061GC060	348?	9006	None	None	323	None	None	None	None	None	None	106?	None	None	492?	748?	558?	538?	555?
061GC090	386?	7984	None	None	217	None	Trace?	None	None	232?	None	175?	None	None	None	126?	269?	473?	461?
061GC120	Trace?	9262	None	None	Trace?	None	Trace?	None	None	None	None	None	None	None	Trace?	243?	570?	Trace?	None
061GC150	None	9312	None	None	214?	None	Trace?	None	None	None	None	Trace?	None	None	Trace?	246?	536?	None	268?
061GC180	None	9198	7191?	None	233?	None	Trace?	None	None	None	None	None	None	None	None	309?	340?	Trace?	665?
061GC220	271?	9129	3064	None	253?	None	None	None	None	None	None	Trace?	None	None	449?	981?	752?	357?	387?
068BX000	None	9345	None	None	205?	None	None	None	None	None	None	None	None	None	None	None	799?	None	221?
076BX000	None	9341	None	None	336?	None	227?	None	None	None	None	None	None	178?	None	None	724?	None	None
082BX000	None	9382	None	None	None	None	None	None	None	None	None	None	None	None	None	None	1128?	None	None

KEY: None= mineral appears to be absent; Number= mineral intensity; Number+?= possible presence of the mineral shown as intensity; Trace?= mineral possibly there but appears within the noise band


Sample identification: 061GC060
31-Oct-1998 21:59
[counts]
10000
6400
3600
1600
400
0.0
[°2θ]
0
20
40
60
Low Magnesian Calcite
3.035
Orthoclase
3.18
Halite
2.821
Albite
3.196
Muscovite
3.32
Quartz
3.343
061GC060.RD

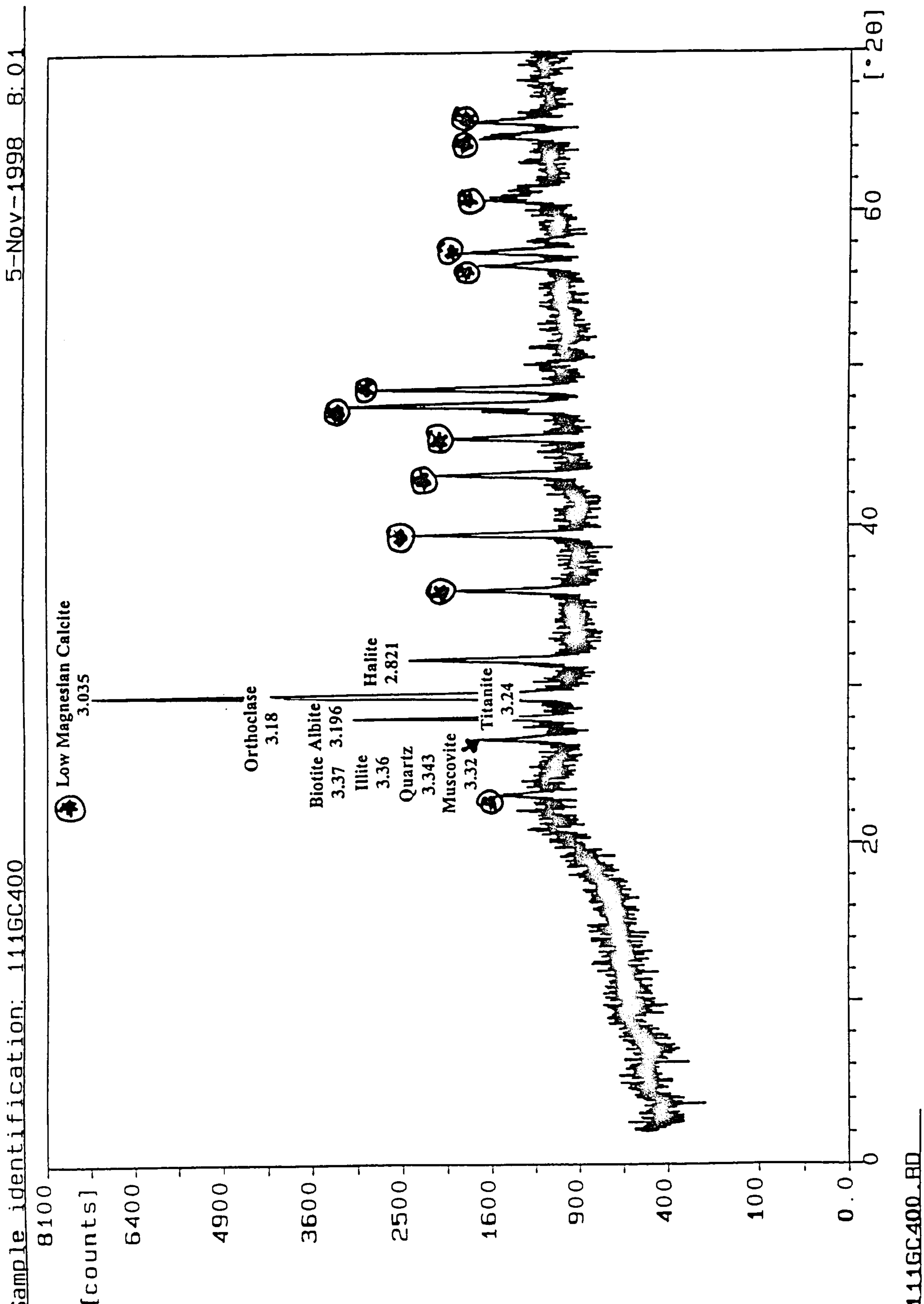
SO 136 West Campbell Plateau
Changes in downcore mineralogy at Site 10, Station 061



Minerals	Carbonate Minerals					Clay Minerals				Micas					Feldspars			
	Aragonite	Low Mg Calcite	High Mg Calcite	Dolomite	Quartz	Illite 1	Illite 2	Illite 3	Smectite/ Kaolinite	Biotite (3A)	Biotite (10A)	Muscovite	Muscovite (3T)	Muscovite (3T)2	Orthoclase	Albite	Halite	Titanite
d(A)	3,396	3,035	2,996	2,886	3,343	4,46	3,36	2,67	7,24	3,37	10,1	3,32	9,97	3,331	3,18	3,196	2,821	3,24
<u>*Emerald Basin (Sites 17 to 21)*</u>																		
100GC000	None	1801	405?	None	4555	None	1044?*	None	Trace?	1044?*	315?	None	471?	4339?	4490?**	4490?**	2765?	852?
111GC000	None	6095	299?	None	1149	None	807?	None	None	291?	None	741?	213?	846?	4103?*	4103?*	1240?	None
111GC100	None	6438	279?	None	1940	None	528?	None	None	None	193?	815?	None	1644?	1214?	750?	785?	None
111GC200	None	5340	298?	None	336	None	None	None	None	None	None	None	None	321?	1782?	1863?	1517?	None
111GC300	212?	4351	251?	None	1249	None	857?	None	None	549?	2047?	449?	259?	828?	486?	563?	1716?	None
111GC400	None	6152	213?	None	747	None	421?	None	None	305?	None	335?	None	483?	2059?*	2059?*	1492?	None
111GC500	None	2677	189?	None	2735	None	730?	None	None	455?	212?	398?	None	822?	2063?	1369?	1161?	601?
111GC530	None	1044	501?	None	1301	None	638?	391?	None	218?	335?	377?	143?	758?	1859?	1200?	1484?	433?
111GC600	None	2024	321?	None	884	None	455?	None	None	253?	177?	204?	265?	380?	412?	320?	2251?	None
111GC700	None	3875	None	None	529	None	286?	481?	None	233?	None	244?	None	285?	441?	399?	2008?	None
111GC800	None	320?	None	None	3850	None	1155?	298?	None	483?	321?	900?	520?	572?	1819?	1892?	1495?	None
111GC900	None	5190	None	None	382	None	None	None	None	161?	None	None	None	233?	542?	249?	1710?	438?
111GC947	None	None	320?	None	5588	None	None	288?	None	952?	247?	642?	216?	None	2044?	1674?	1766?	353?
117GC000	None	2973	313?	None	3249	None	1122	None	None	538?	387	None	316?	2219	3123?*	3123?*	729?	6583

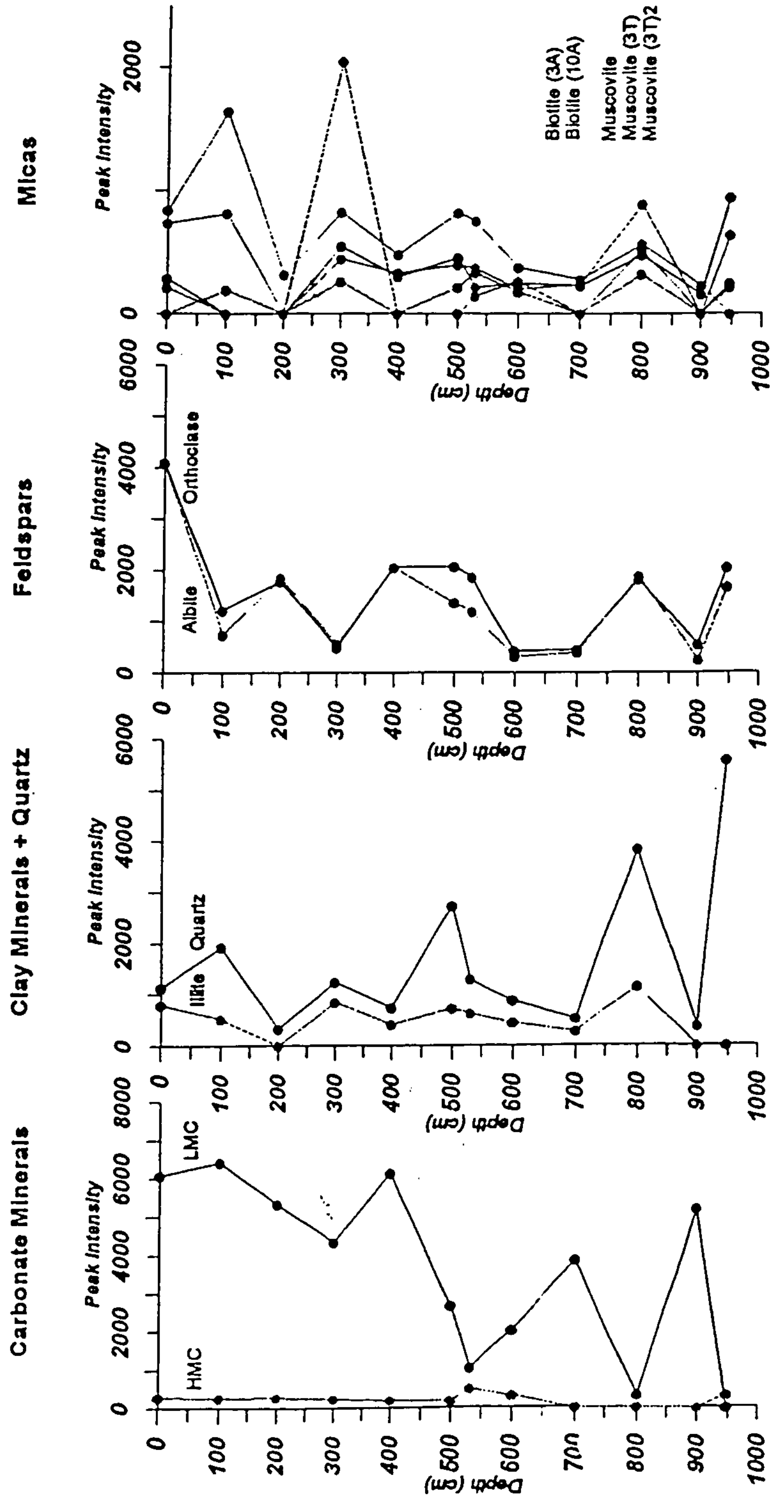
Minerals	Carbonate Minerals					Clay Minerals				Micas					Feldspars		
	Aragonite	Low Mg Calcite	High Mg Calcite	Dolomite	Quartz	Illite 1	Illite 2	Illite 3	Smectite/ Kaolinite	Biotite (3A)	Biotite (10A)	Muscovite	Muscovite (3T)	Muscovite (3T)2	Orthoclase	Albite	Halite
d(A)	3,396	3,035	2,996	2,886	3,343	4,46	3,36	2,67	7,24	3,37	10,1	3,32	9,97	3,331	3,18	3,196	2,821
<u>*S. Tasman Rise (Sites 22 to)*</u>																	
124GC000	None	9198	None	None	1362	None	823?	None	None	369?	None	748?	None	1196?	370?	241?	1002?
140BX000	None	9332	None	None	177?	None	None	None	None	None	None	None	None	None	None	None	826?
147BX000	None	9364	None	None	268?	None	None	None	None	None	None	None	None	None	None	None	628?

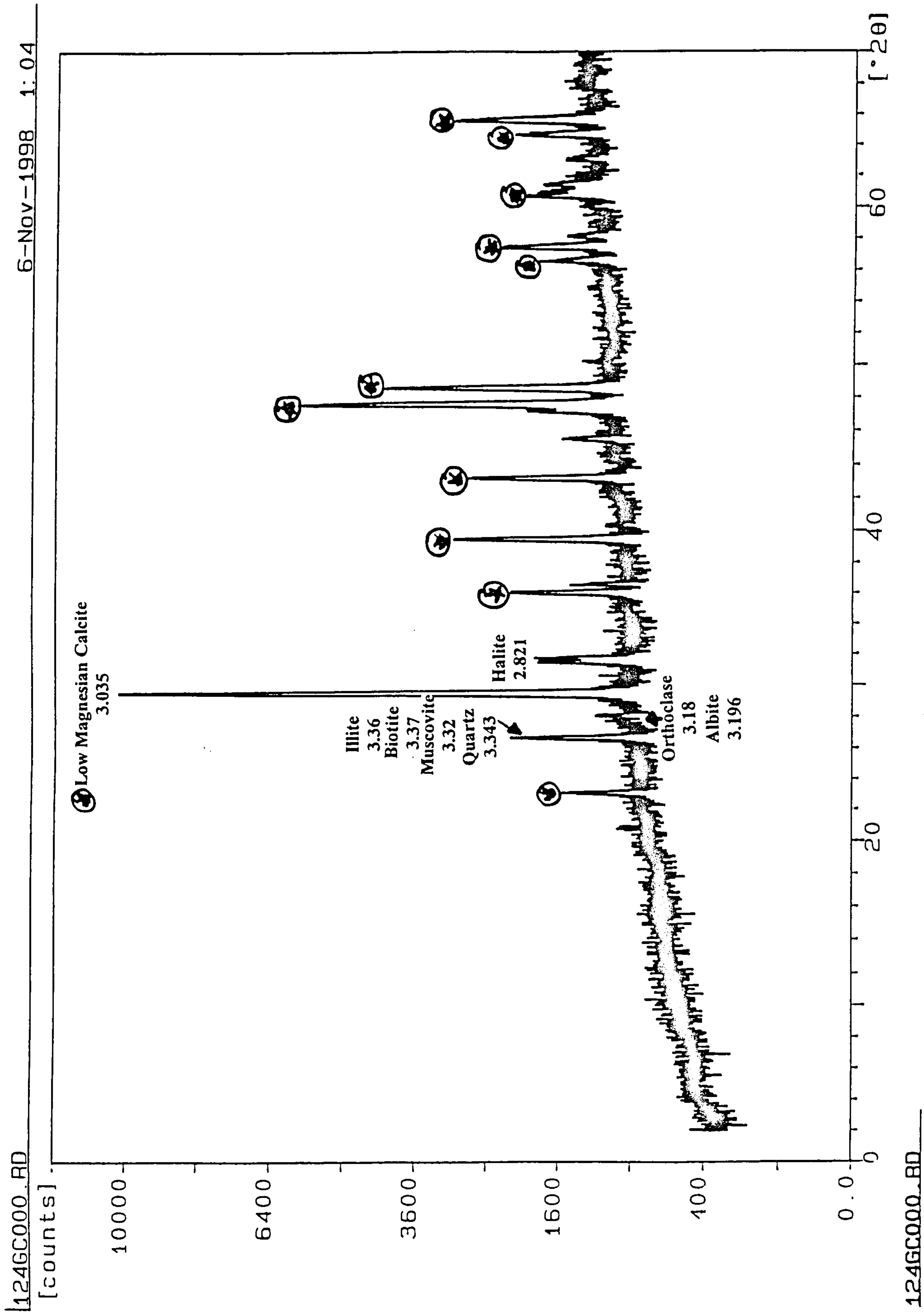
KEY; None= mineral appears to be absent; Number= mineral intensity; Number+?= possible presence of the mineral shown as intensity; Trace?= mineral possibly there but appears within the noise band


Sample identification: 111GC400
5-Nov-1998 8:01
[counts]
8100
6400
4900
3600
2500
1600
900
400
100
0.0
0
20
40
60
[°2θ]
Low Magnesian Calcite 3.035
Orthoclase 3.18
Biotite 3.37
Albite 3.196
Illite 3.36
Halite 2.821
Quartz 3.343
Titanite 3.24
Muscovite 3.32
111GC400.RD

SO 136 Emerald Basin

Changes in downcore mineralogy at Site 20, Station 111

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3600
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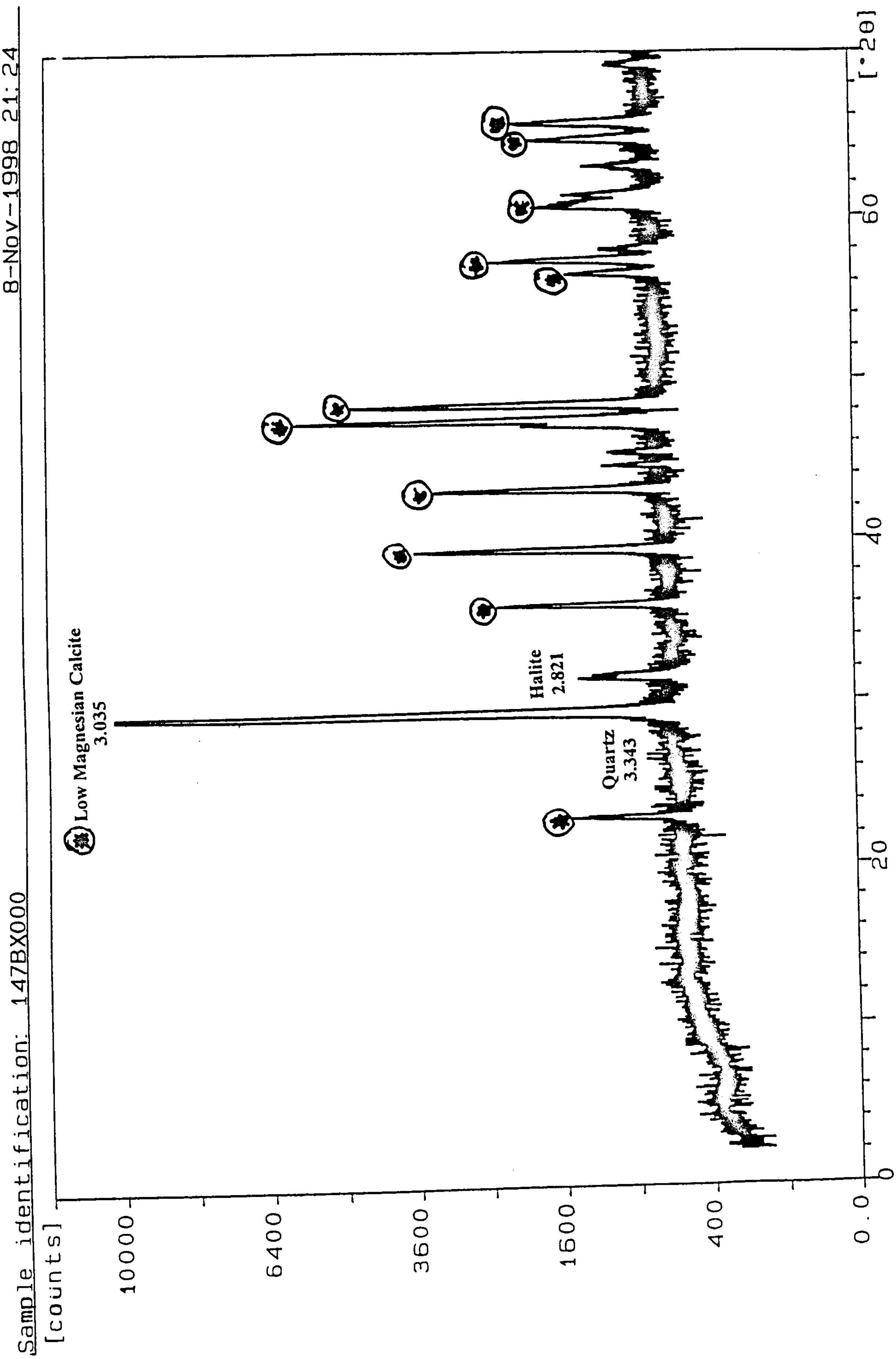
40
60
Low Magnesian Calcite
3.035
Halite
2.821
Illite
3.36
Biotite
3.37
Muscovite
3.32
Quartz
3.343
Orthoclase
3.18
Albite
3.196
124GC000.RD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Low Magnesian Calcite
3.035
Halite
2.821
Quartz
3.343

List of XRD samples		
Core	**Depth in Core**	**File Name**
(ss=surface sample, bs=base sample)		
SO136-003GC	000-005(ss)	003GC05.RD\UDF
SO136-003GC	124-126	003GC125.RD\UDF
SO136-003GC	214-216	003GC215.RD\UDF
SO136-003GC	304-306	003GC305.RD\UDF
SO136-003GC	424-426	003GC425.RD\UDF
SO136-003GC	514-516	003GC515.RD\UDF
SO136-003GC	604-606	003GC605.RD\UDF
SO136-003GC	724-726	003GC725.RD\UDF
SO136-004MUC	000-002(ss)	004MUC00.RD\UDF
SO136-011GC	000-001(ss)	011GC01.RD\UDF
SO136-025BX	lop layer(ss)	025BXTL.RD\UDF
SO136-025BX	middle layer	025BXML.RD\UDF
SO136-025BX	bottom layer	025BXBL.RD\UDF
SO136-031BX	top layer(ss)	031BXTL.RD\UDF
SO136-031BX	bottom layer	031BXBL.RD\UDF
SO136-038GC	000-001(ss)	038GC000.RD\UDF
SO136-038GC	050-051	038GC050.RD\UDF
SO136-038GC	100-101	038GC100.RD\UDF
SO136-038GC	150-151	038GC150.RD\UDF
SO136-038GC	200-201	038GC200.RD\UDF
SO136-038GC	250-251	038GC250.RD\UDF
SO136-038GC	300-301	038GC300.RD\UDF
SO136-038GC	350-351	038GC350.RD\UDF
SO136-038GC	400-401	038GC400.RD\UDF
SO136-044GC	000-002(ss)	044GC002.RD\UDF
SO136-051GC	000-001(ss)	051GC001.RD\UDF
SO136-055GC	000-001(ss)	055GC000.RD\UDF
SO136-061GC	000-005(ss)	003GC05.RD\UDF
SO136-061GC	124-126	003GC125.RD\UDF
SO136-061GC	214-216	003GC215.RD\UDF
SO136-061GC	304-306	003GC305.RD\UDF
SO136-061GC	424-426	003GC425.RD\UDF
SO136-061GC	514-516	003GC515.RD\UDF
SO136-061GC	604-606	003GC605.RD\UDF
SO136-061GC	724-726	003GC725.RD\UDF
SO136-068BX	000-001(ss)	068BX000.RD\UDF
SO136-076BX	000-001(ss)	076BX000.RD\UDF
SO136-082BX	000-001(ss)	082BX000.RD\UDF
SO136-100GC	000-001(ss)	100GC000.RD\UDF
SO136-111GC	000-001(ss)	111GC000.RD\UDF
SO136-111GC	100-101	111GC100.RD\UDF
SO136-111GC	200-201	111GC200.RD\UDF
SO136-111GC	300-301	111GC300.RD\UDF
SO136-111GC	400-401	111GC400.RD\UDF
SO136-111GC	500-501	111GC500.RD\UDF
SO136-111GC	530-531	111GC530.RD\UDF
SO136-111GC	600-601	111GC600.RD\UDF
SO136-111GC	700-701	111GC700.RD\UDF
SO136-111GC	800-801	111GC800.RD\UDF
SO136-111GC	900-901	111GC900.RD\UDF
SO136-111GC	947-948(bs)	111GC947.RD\UDF
SO136-111GC	000-001(ss)	117GC000.RD\UDF
SO136-124GC	000-001(ss)	124GC000.RD\UDF
SO136-140BX	000-001(ss)	140BX000.RD\UDF
SO136-147BX	000-001(ss)	147BX000.RD\UDF

Challenger Plateau: measured phosphate [µmol/l]

	CTD 007 970 m		CTD 010 1554 m	
	c	depth	c	depth
Niskin 24	3,15	947	5,72	1515
others	2,42	960	5,16	1000
	1,21	350	2,87	750
	0,89	200	1,97	500
	0,37	100	0,86	200
	0,37	50	0,55	100
	0,37	30	0,48	50
	0,37	10	0,48	30
			0,44	10

East Campbell Plateau: measured phosphate [µmol/l]

	CTD 016 4521 m		CTD 023 3440 m		CTD 028 1570 m		CTD 035 1360 m		CTD 041 960 m		CTD 048 750 m		CTD 052 561 m	
	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth
Niskin 24	2,69	4500	3,58	3400	2,25	1500	2,25	1300	2,54	1300	1,34	700	1,83	500
others	2,31	4500	2,28	3400	1,92	1500	2,34	1300	1,99	1300	1,68	700	1,87	500
	2,12	3000	2,82	3000	1,76	1250	2,28	1000	1,76	1000	1,57	700	1,42	350
	1,83	2000	2,63	2000	1,79	1000	1,27	750	1,24	750	1,23	500	1,45	200
	1,64	1000	2,91	1000	1,69	750	1,37	300	1,34	300	1,15	200	1,38	100
	2,18	500	1,39	500	0,98	500	1,08	200	1,63	200	1,04	100	1,34	50
	1,10	200	1,04	200	0,85	200	1,08	100	1,53	100	0,89	50	1,30	30
	1,33	100	1,17	100	1,17	100	0,98	50	1,24	50	1,19	30	1,27	10
	1,10	50	1,33	50	1,04	50	0,91	30	1,08	30	1,04	10		
	1,39	30	1,26	10	0,82	30	1,21	10						
	1,04	10			1,08	10								

West Campbell Plateau: measured phosphate [µmol/l]

	(CTD 059) 600 m		CTD 059 600 m		CTD 065 981 m		CTD 073 1109 m		CTD 080 1677 m		CTD 086 2074 m		CTD 091 2998 m		CTD 096 4157 m	
Niskin No	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth
24	2,17	580			2,78	950	1,94	1050	1,14	1650	2,40	2000	2,58	2900	2,96	4100
23	2,09	580	2,15	580	2,71	950	2,13	1050	1,29	1650	2,25	2000	2,96	2900	2,92	4100
22	2,13	580	1,85	500	2,17	750	1,48	750	1,18	1500	1,87	1500	3,93	2500	2,55	3000
21	2,13	580	1,75	400	1,59	500	0,99	500	1,18	1000	1,72	1000	3,74	2000	2,81	2000
20	2,22	580	1,62	300	1,52	200	1,06	200	1,14	500	0,86	500	3,29	1500	2,13	1000
19	1,82	500	1,64	200	1,70	100	1,18	100	1,10	200	1,01	200	2,88	1000	1,83	500
18	1,91	500	1,59	100	1,70	50	1,33	50	2,24	100	1,01	100	1,76	500	1,54	200
17	1,82	500	1,84	50	1,67	30	1,37	30	2,21	50	1,50	50	1,12	200	1,20	100
16	1,86	400	1,55	30	1,67	10	1,26	10	2,97	30	1,50	30	1,09	100	1,01	50
15	1,64	400	1,66	10					3,84	10	1,31	10	1,27	50	1,65	30
14	1,73	300											1,57	10	1,46	10
13	1,59	300														
12	1,55	300														
11	1,64	200														
10	1,64	200														
9	1,59	100														
8	1,59	100														
7	1,59	100														
6	1,82	50														
5	1,86	50														
4	1,55	30														
3	1,55	30														
2	1,55	10														
1	1,77	10														

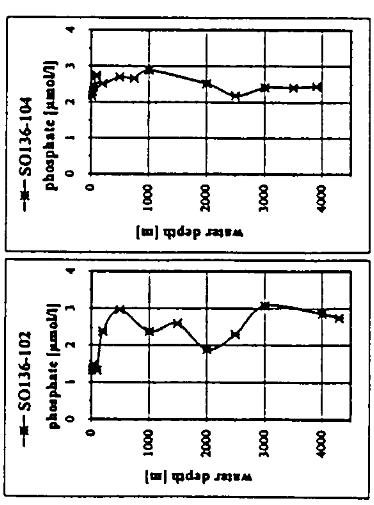
Emerald Basin: measured phosphate [µmol/l]

	CTD 102 4345 m		CTD 104 4000 m	
	c	depth	c	depth
Niskin 24	2,37	4300	2,56	3900
others	1,77	3500	2,44	3900
	2,74	4300	2,41	3500
	2,85	4000	2,41	3000
	3,08	3000	2,18	2500
	2,29	2500	2,52	2000
	1,89	2000	2,89	1000
	2,59	1500	2,67	750
	2,37	1000	2,70	500
	2,96	500	2,52	200
	2,37	200	2,74	100
	1,33	100	2,44	50
	1,48	50	2,29	30
	1,48	30	2,18	10
	1,33	10		

South Tasman Rise: measured phosphate [µmol/l]

	CTD 118 3886 m		CTD 127 4035 m		CTD 132 3386 m		CTD 136 3026 m		CTD 144 2176 m		CTD 151 1842 m		CTD 159 3691 m	
	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth	c	depth
Niskin 24	4,31	3800	4,35	4000	5,08	3300	3,12	3000	2,99	2100	3,93	1800	4,79	3650
others	3,89	3800	3,39	4000	4,01	3300	3,62	3000	3,11	2100	3,93	1800	4,71	3650
	3,51	3000	2,81	3000	3,66	3000	3,47	2500	3,07	1500	3,81	1500	3,44	3000
	3,58	2500	2,51	2500	3,43	2500	3,74	2000	3,28	1000	2,66	1000	3,69	2500
	3,62	2000	2,78	2000	3,28	2000	3,66	1500	3,36	500	1,31	500	3,40	2000
	3,01	1500	2,39	1500	3,20	1500	3,01	1000	1,64	200	1,35	200	3,24	1500
	2,54	1000	2,04	1000	3,20	1000	1,35	500	1,68	100	1,31	100	2,66	1000
	1,74	500	1,85	500	2,74	500	1,58	200	1,60	50	1,27	50	1,68	500
	1,39	200	1,04	200	2,08	200	1,62	100	1,76	30	1,31	30	1,31	200
	1,93	100	1,12	100	1,39	100	1,39	50	1,35	10	1,44	10	1,03	100
	1,81	50	1,12	50	1,70	50	1,16	30					1,31	50
	1,85	30	1,24	30	1,74	10	1,51	10					1,19	30
	-0,03	10	1,35	10									1,27	10

Emerald Basin



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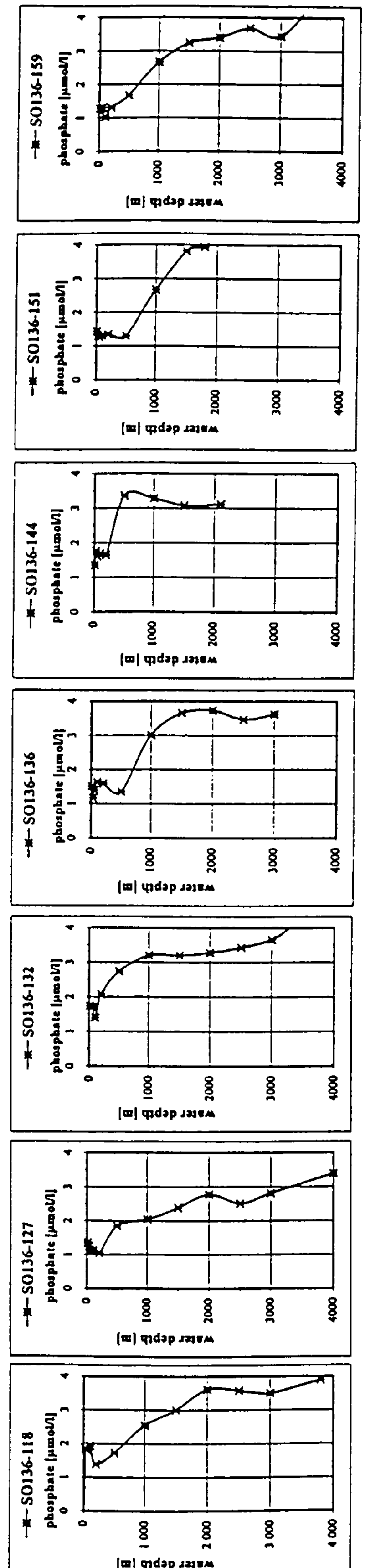
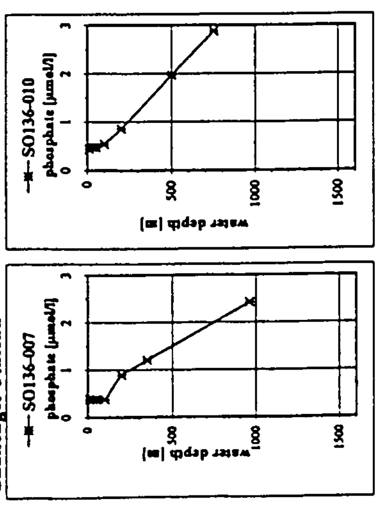


Challenger Plateau



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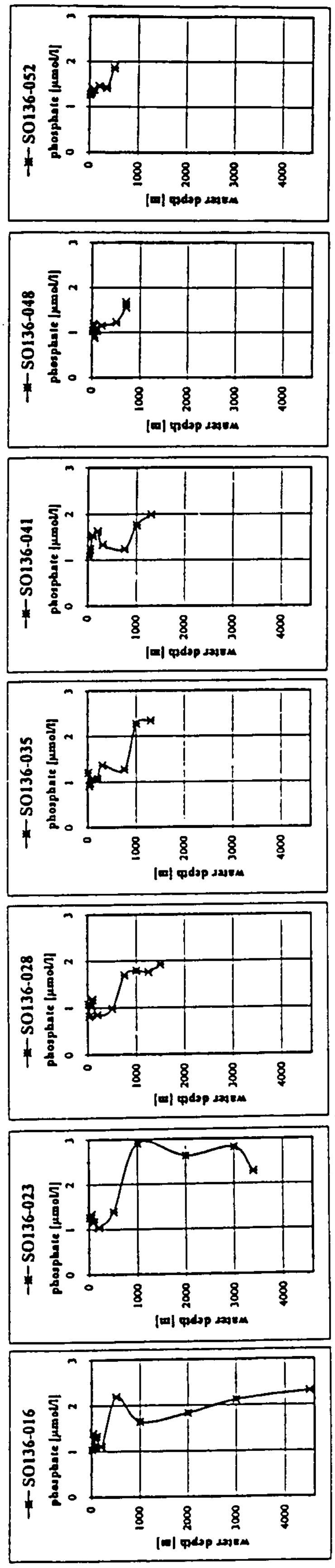
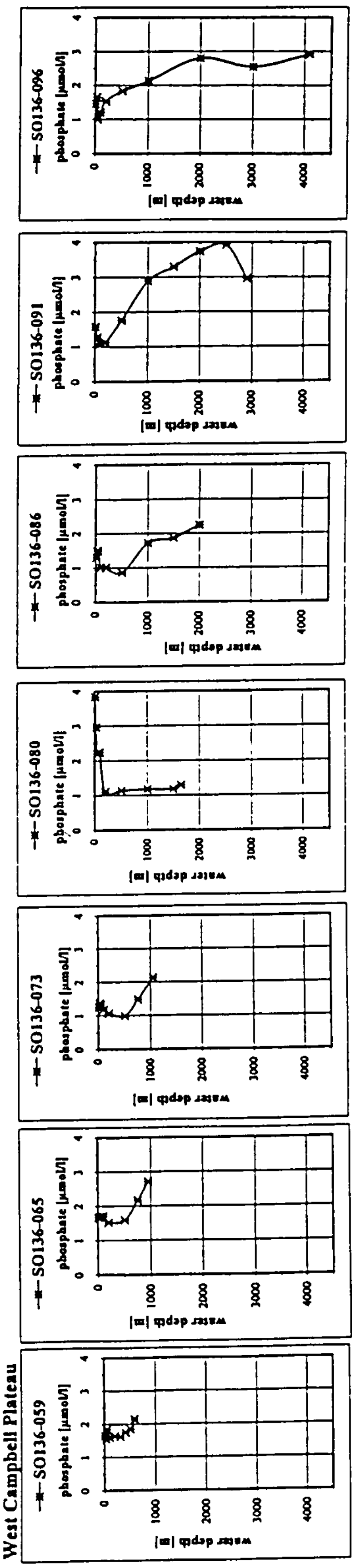
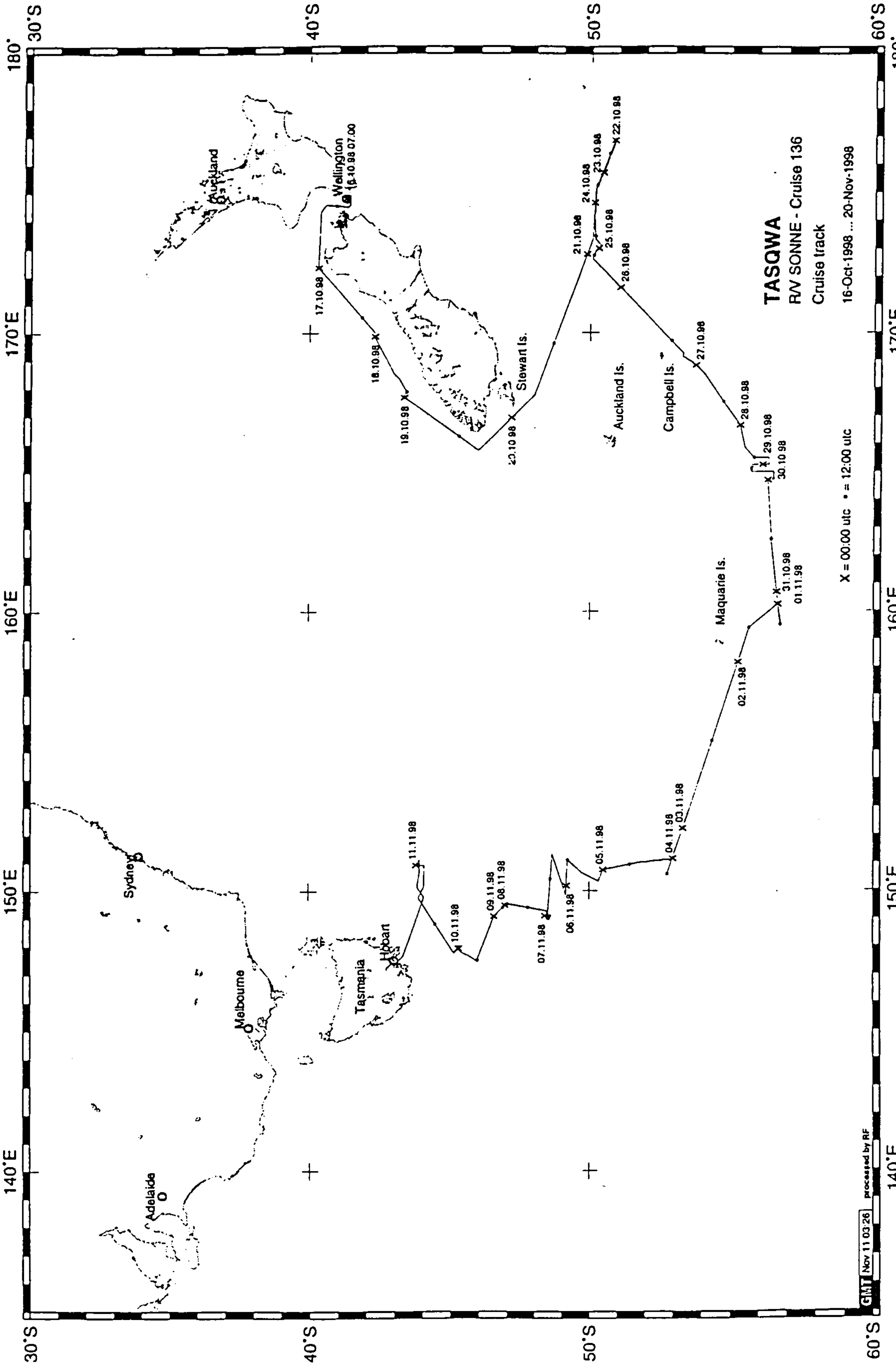


West Campbell Plateau

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Campbell Is.
Maquarie Is.
Sydney
Melbourne
Adelaide
Tasmania
Hobart
30°S
40°S
50°S
60°S
180°
170°E
160°E
150°E
140°E
processed by RF

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